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(51) INT CL[5]
G06F 13/38, G11B 20/10

(52) UK CL (Edition K)
G4A AMX

(56) Documents cited
EP 0243020 A2 EP 0173411 A2

(58) Field of search
UK CL (Edition K) G4A AMG2 AMX
INT CL[5] G06F, G11B

(54) Data storage control

(57) A storage control method and an apparatus, including a buffer 4 for saving in second storage apparatus 8 (e.g. for back-up) a series of data which have been separately stored in a plurality of first storage apparatuses 7, are disclosed. Data blocks of a predetermined size are read into the buffer 4 from each of the first storage apparatuses 7 in a parallel mode. To each of the data blocks an identifier is added which specifies a position, within the first storage apparatuses 7, at which this data was stored. The identifier may also specify a sequential relation in a series of data being stored in the buffer 4. The data from the buffer is stored in the second storage apparatus 8 together with the identifiers. A series of data are restored together with their sequential relation from the second storage apparatus 8 by reference to the identifiers.

FIG. 1

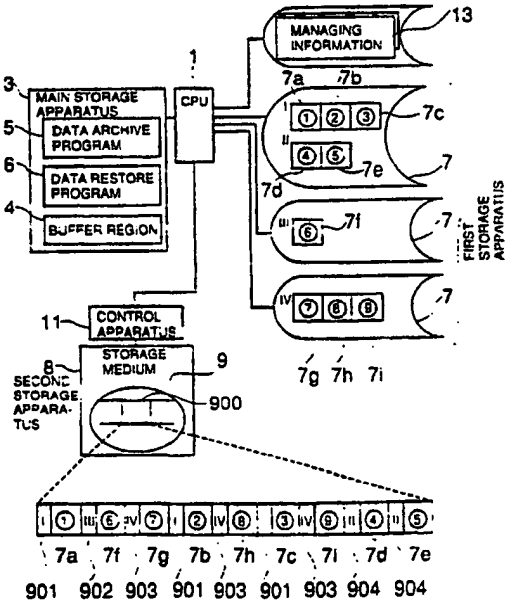

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FIG. 1

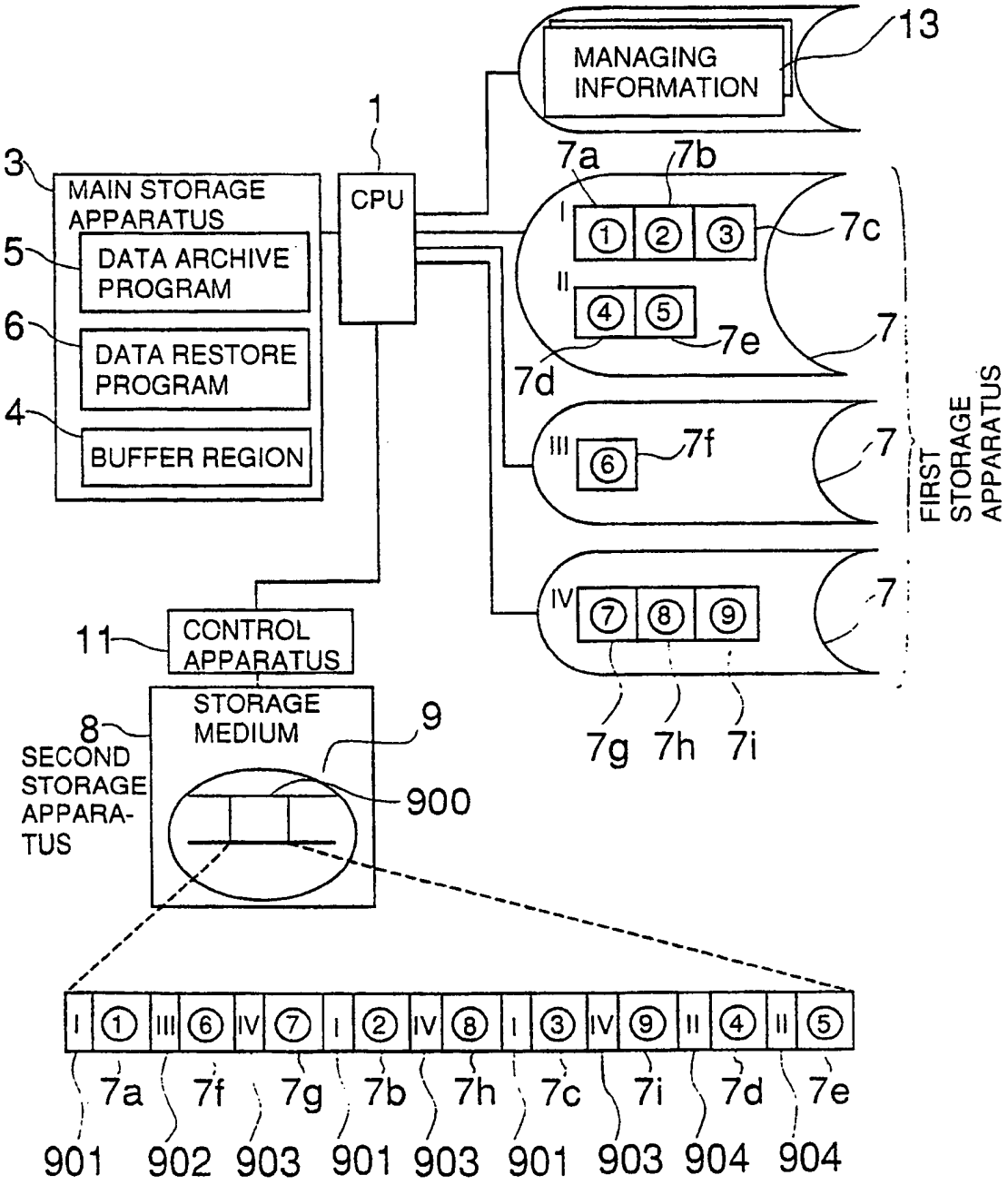


FIG. 2

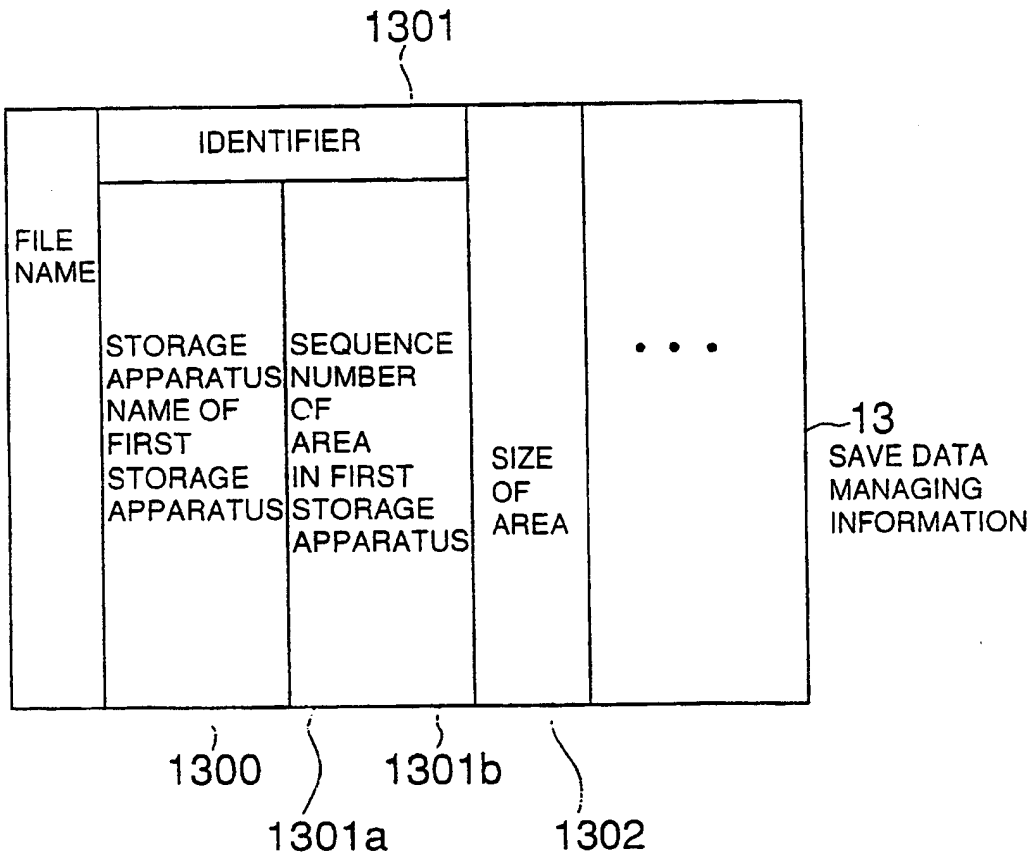


FIG. 3

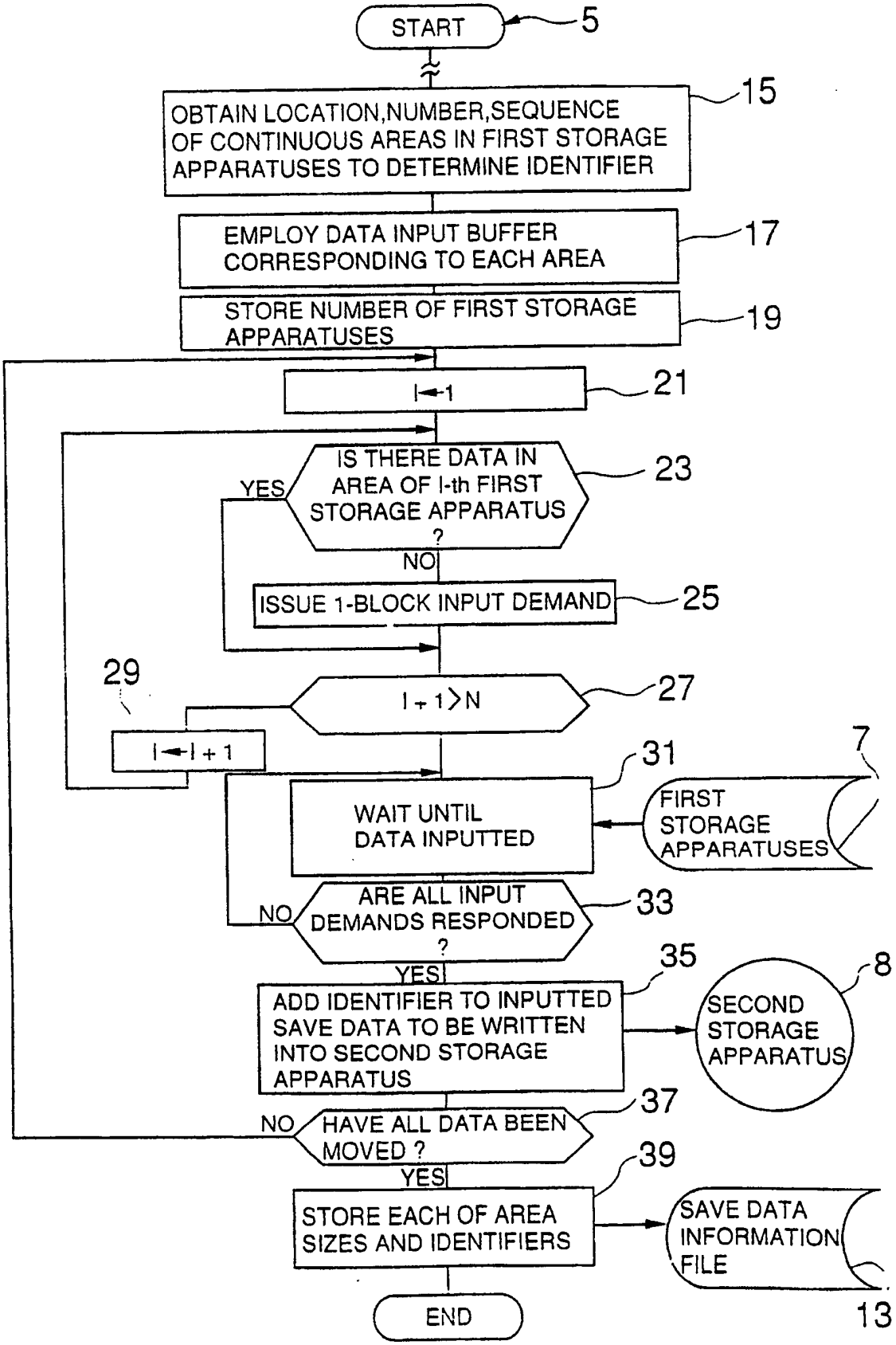


FIG. 4

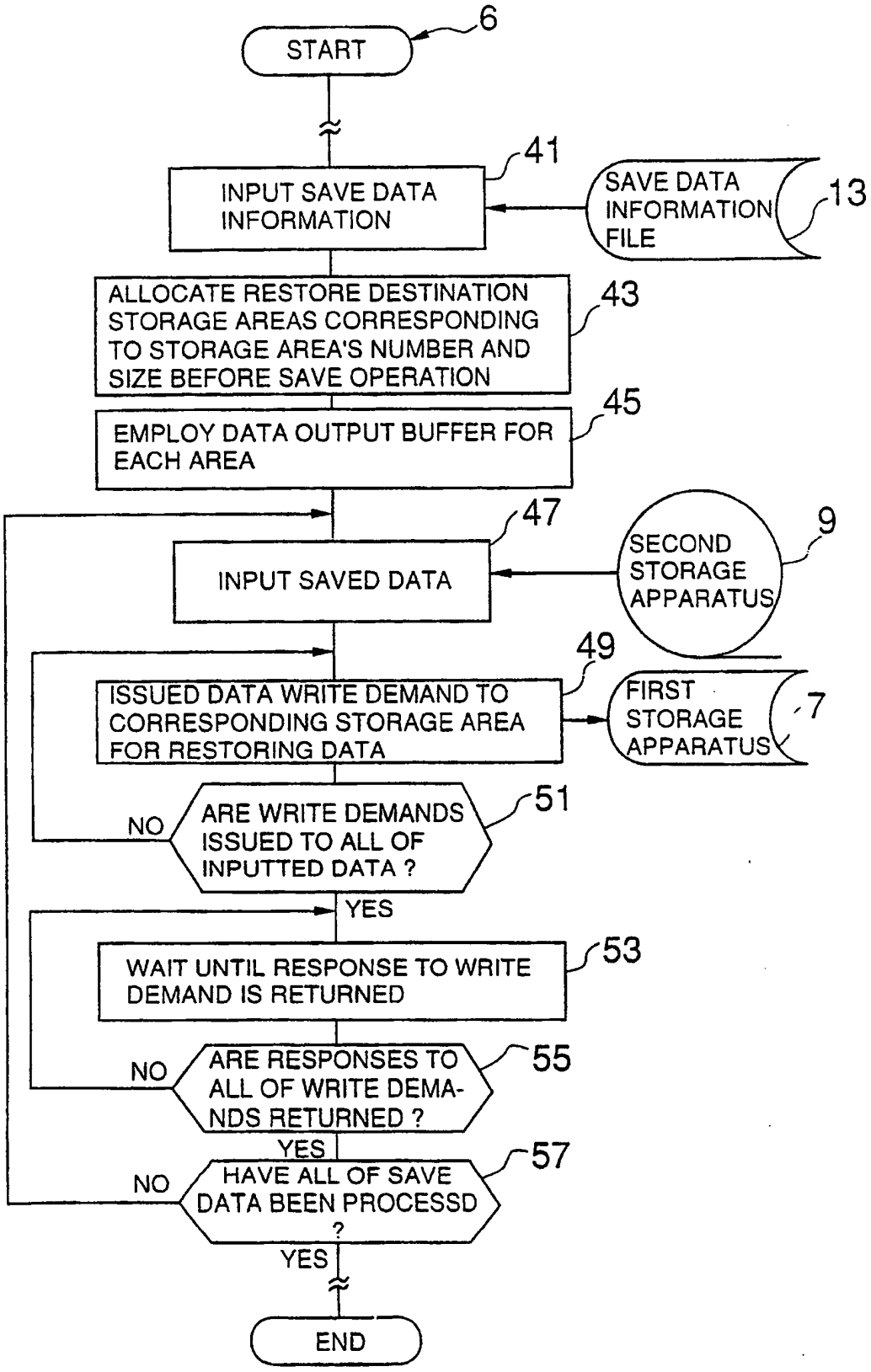


FIG. 5

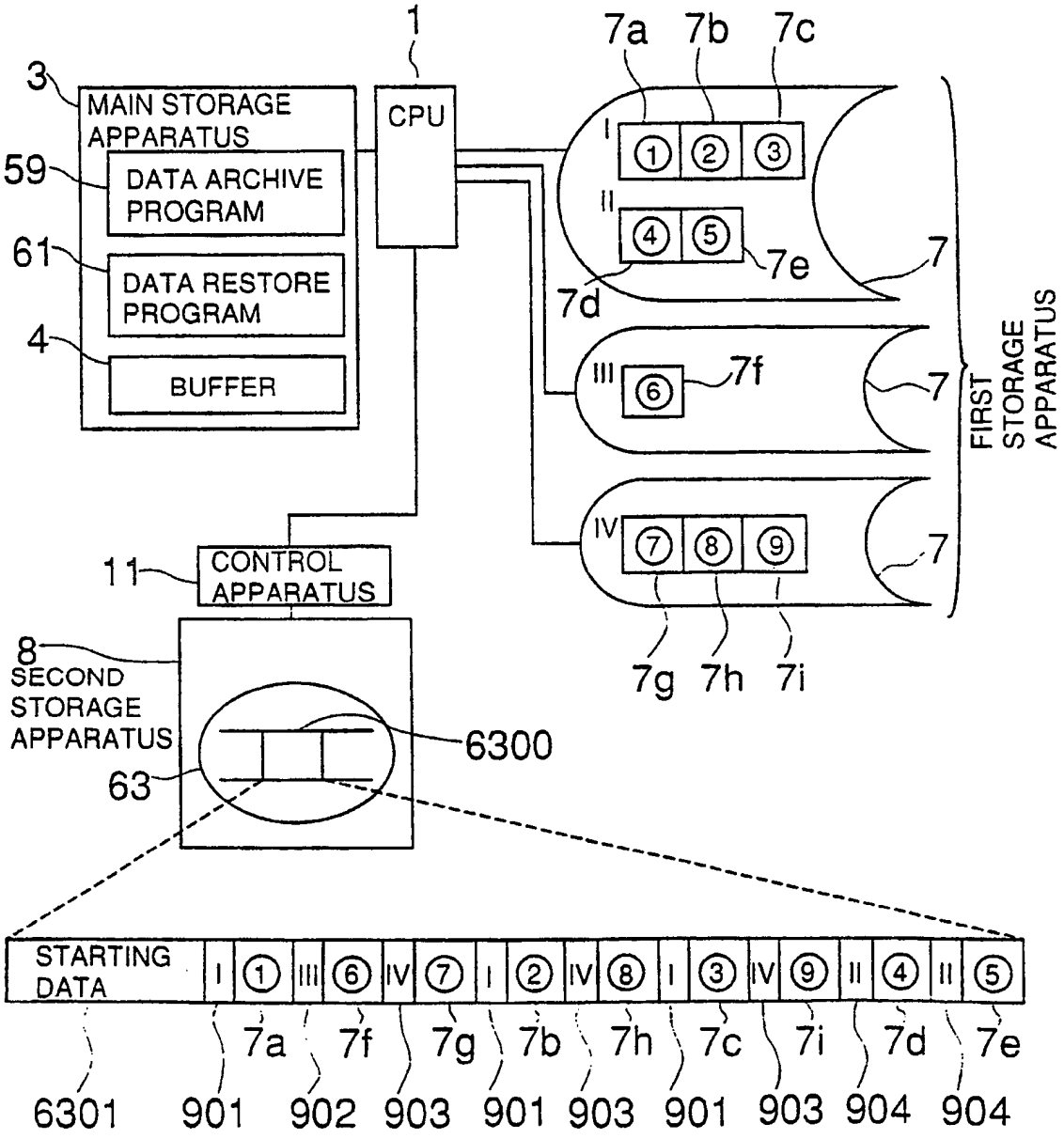


FIG. 6

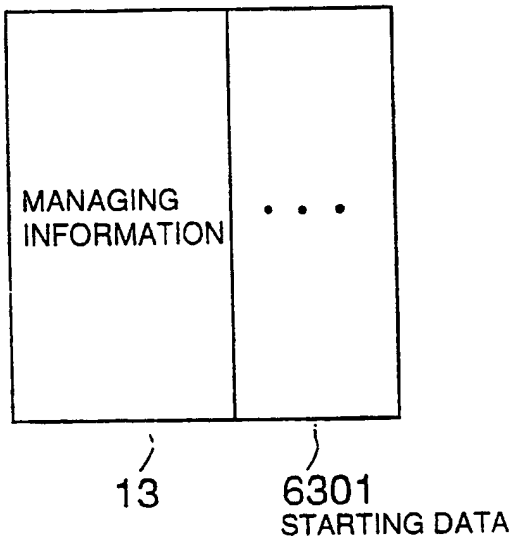


FIG. 7

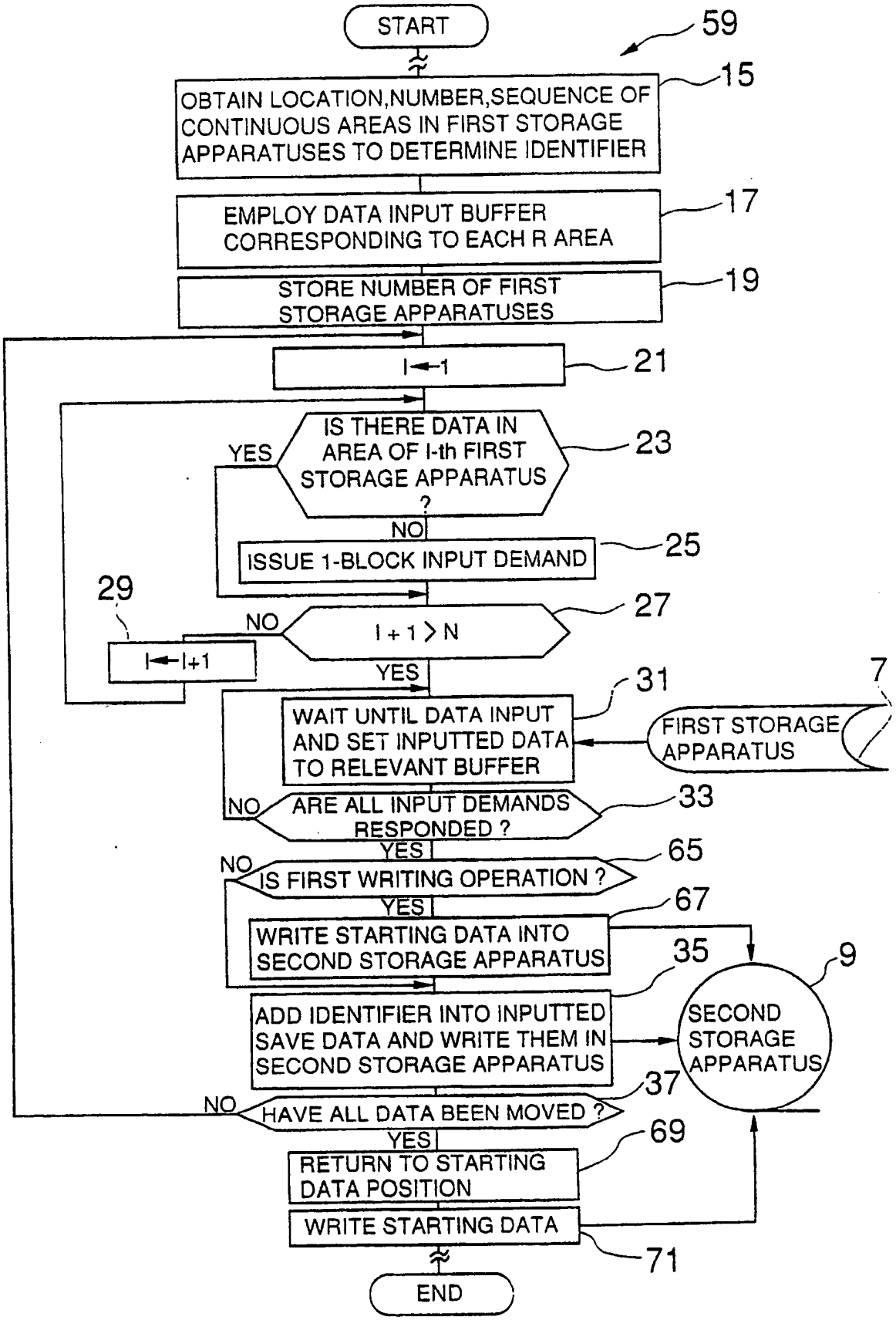


FIG. 8

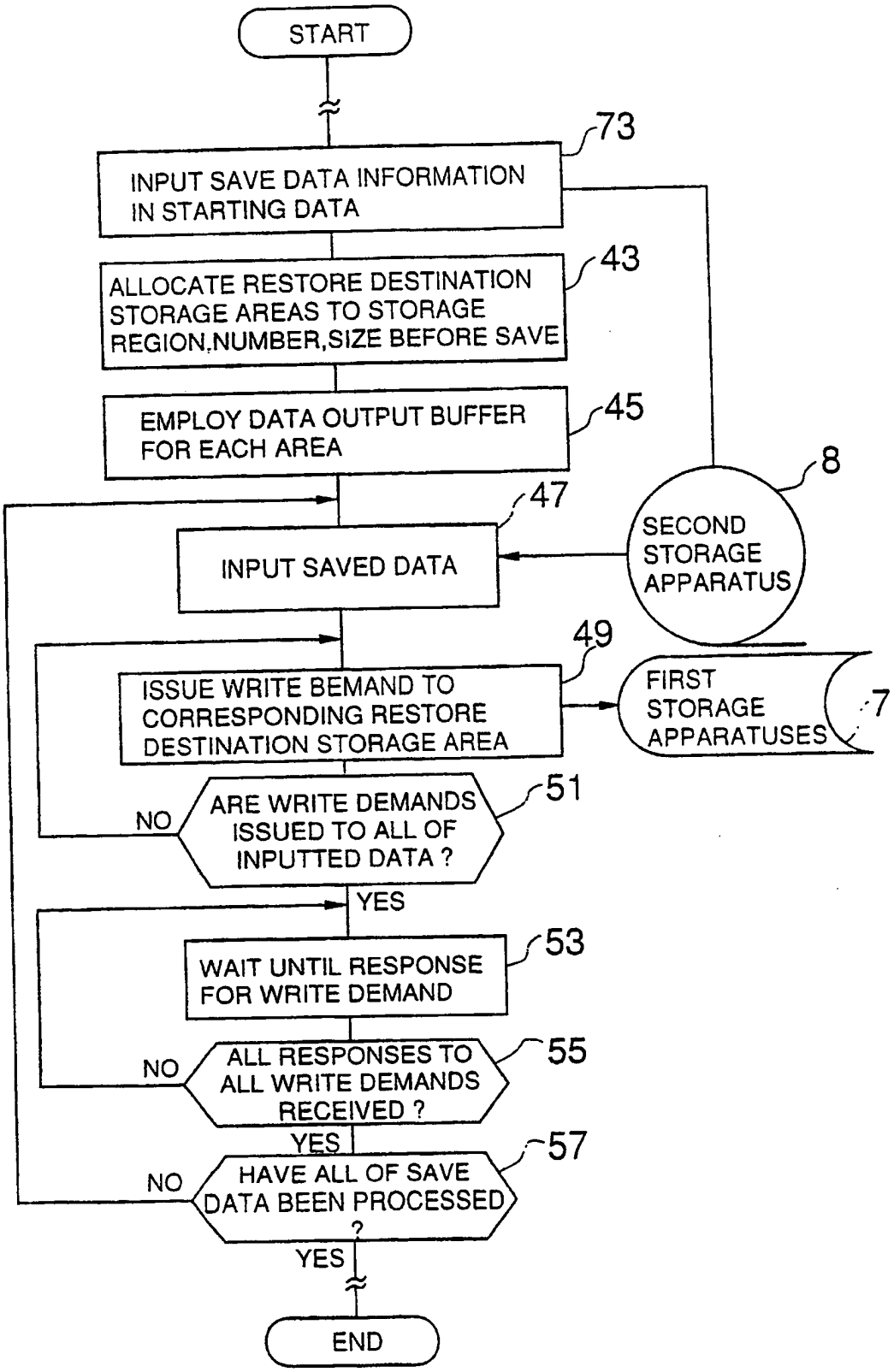


FIG. 9

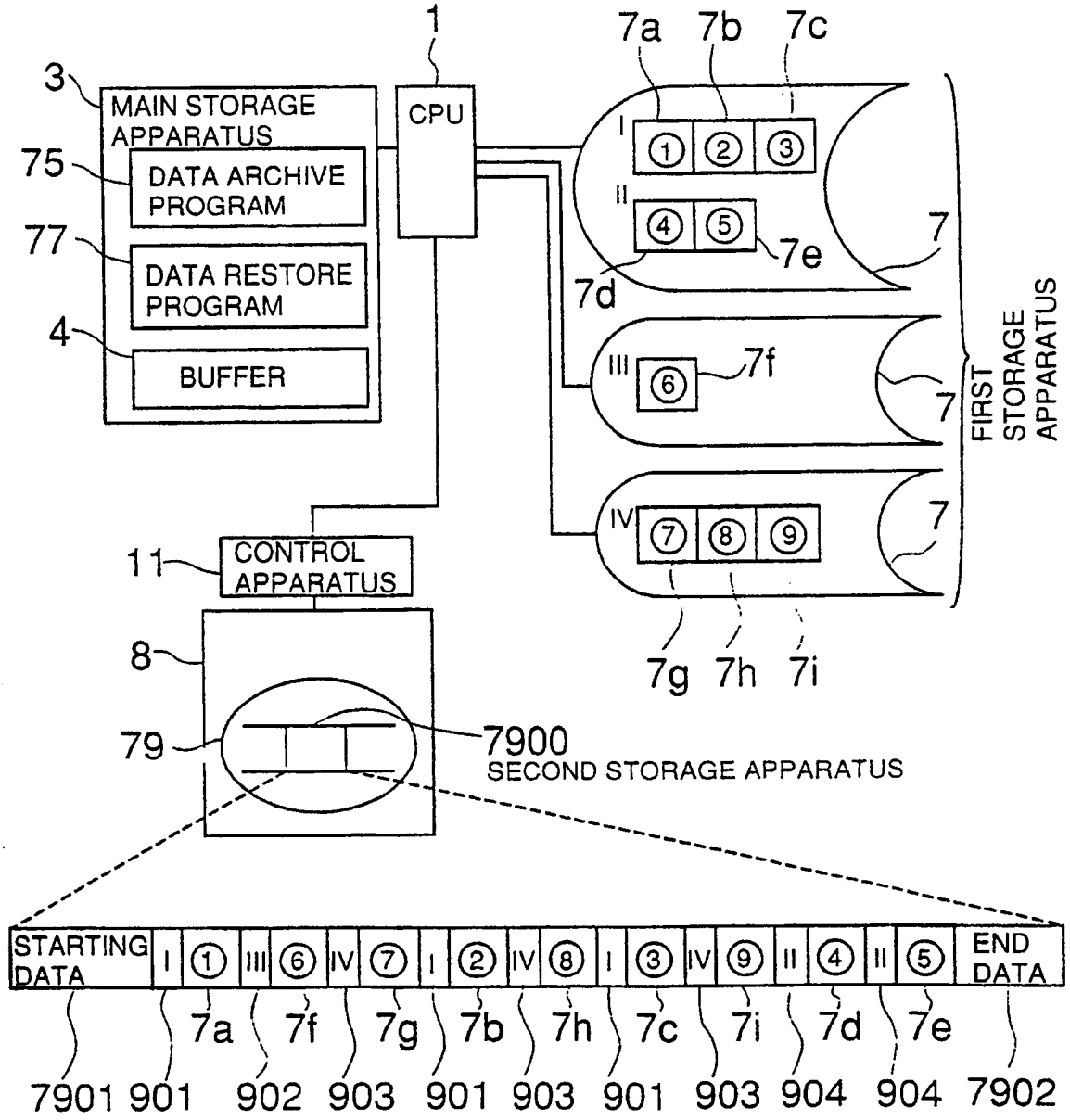


FIG. 10

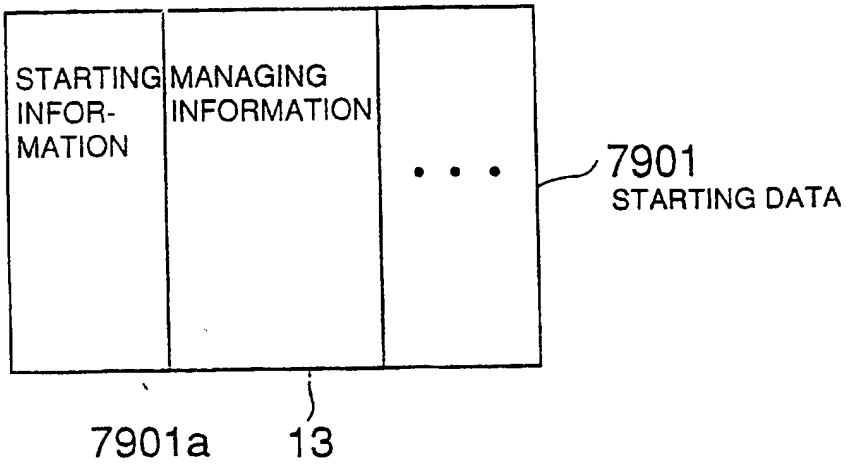


FIG. 11

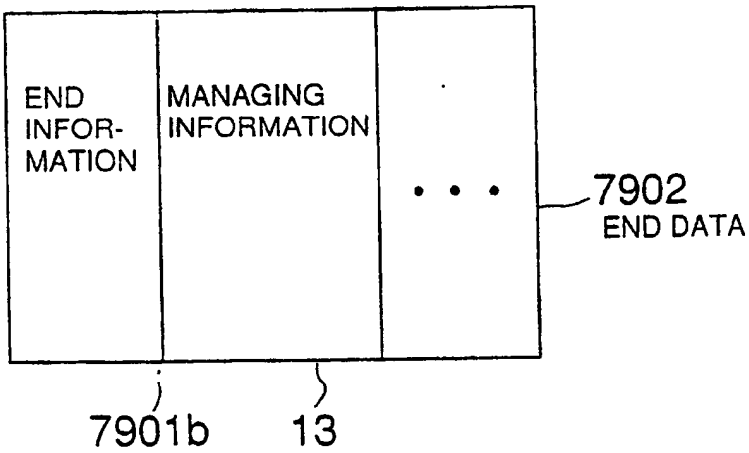


FIG. 12

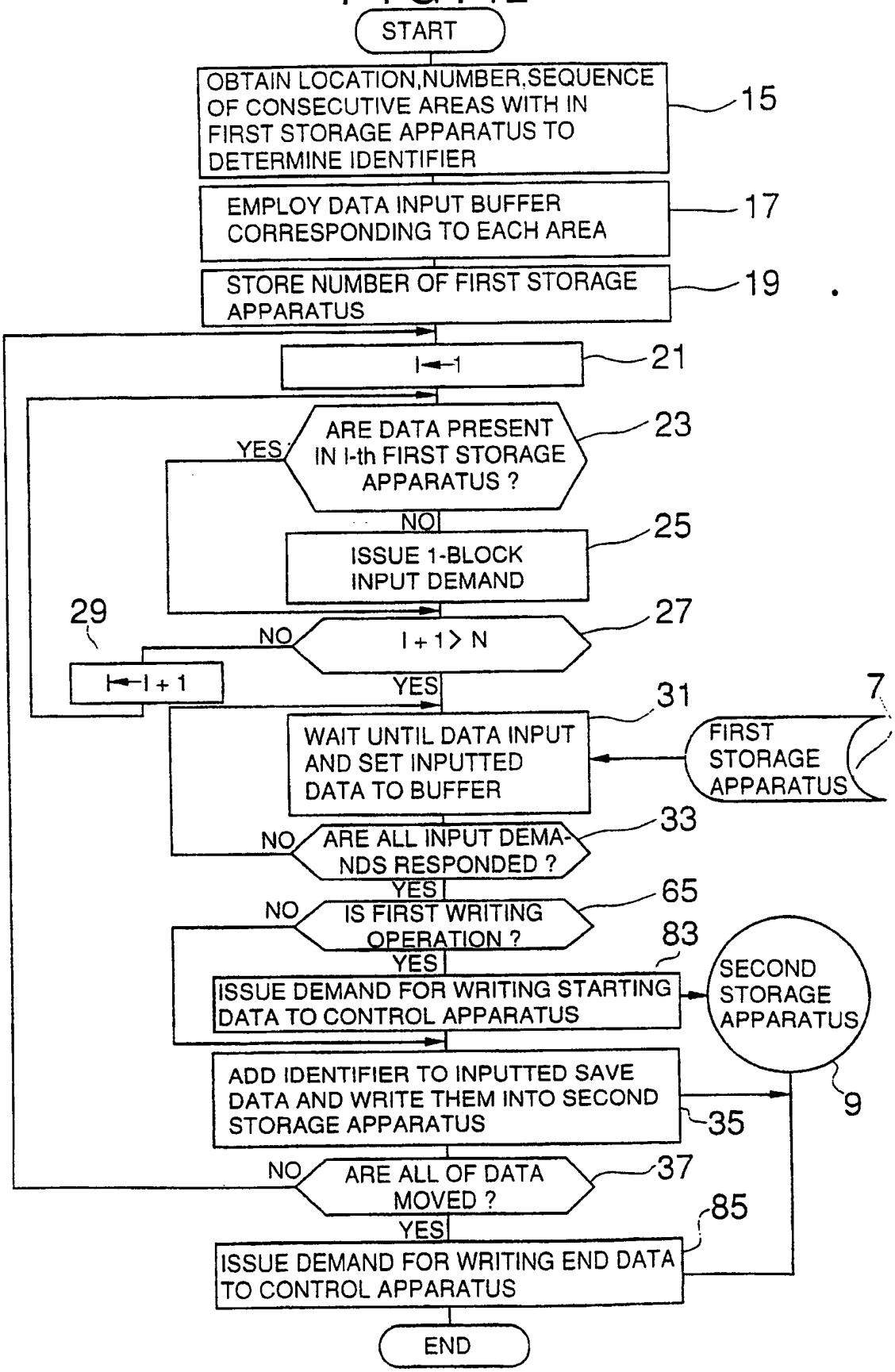


FIG. 13

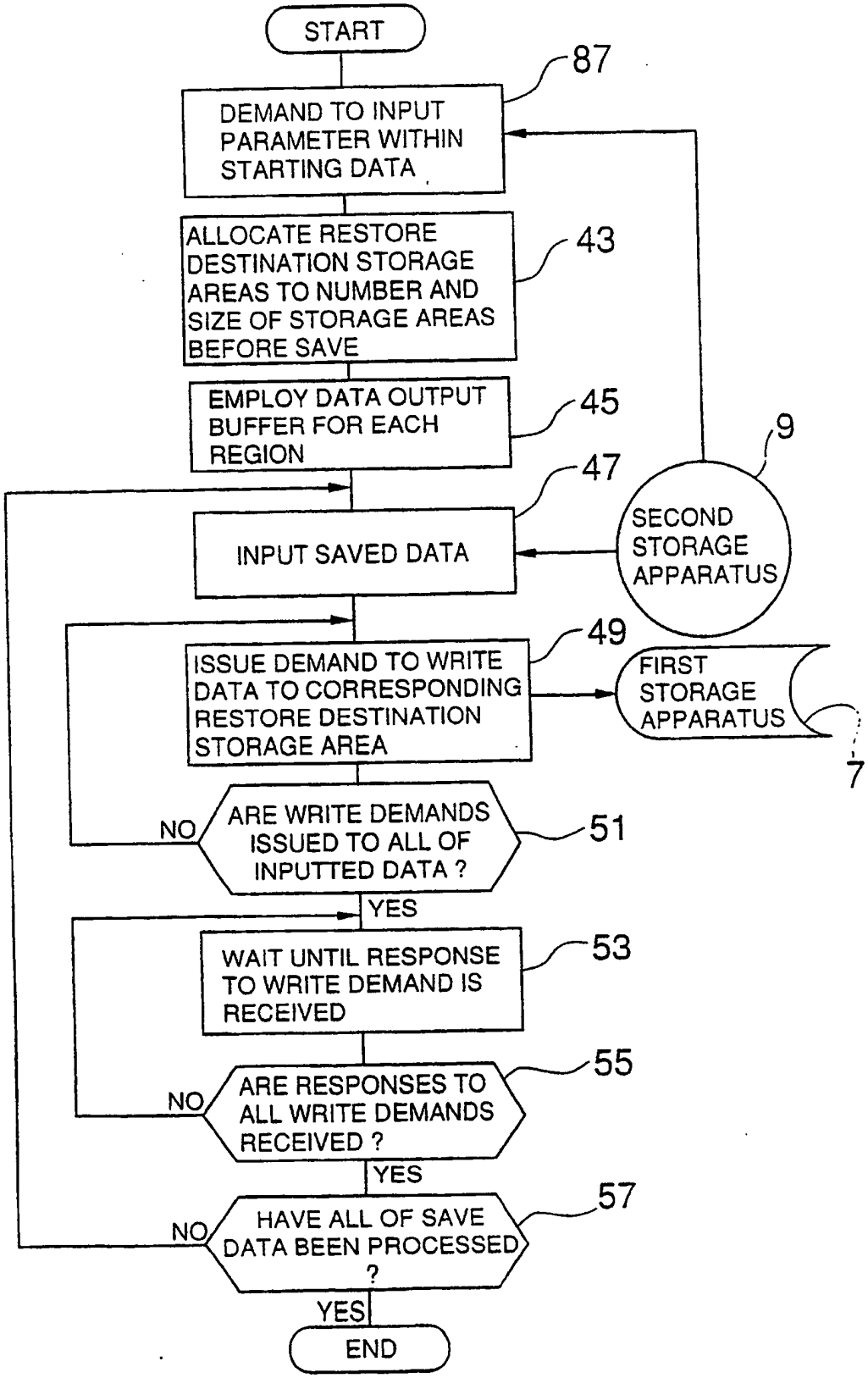


FIG. 14

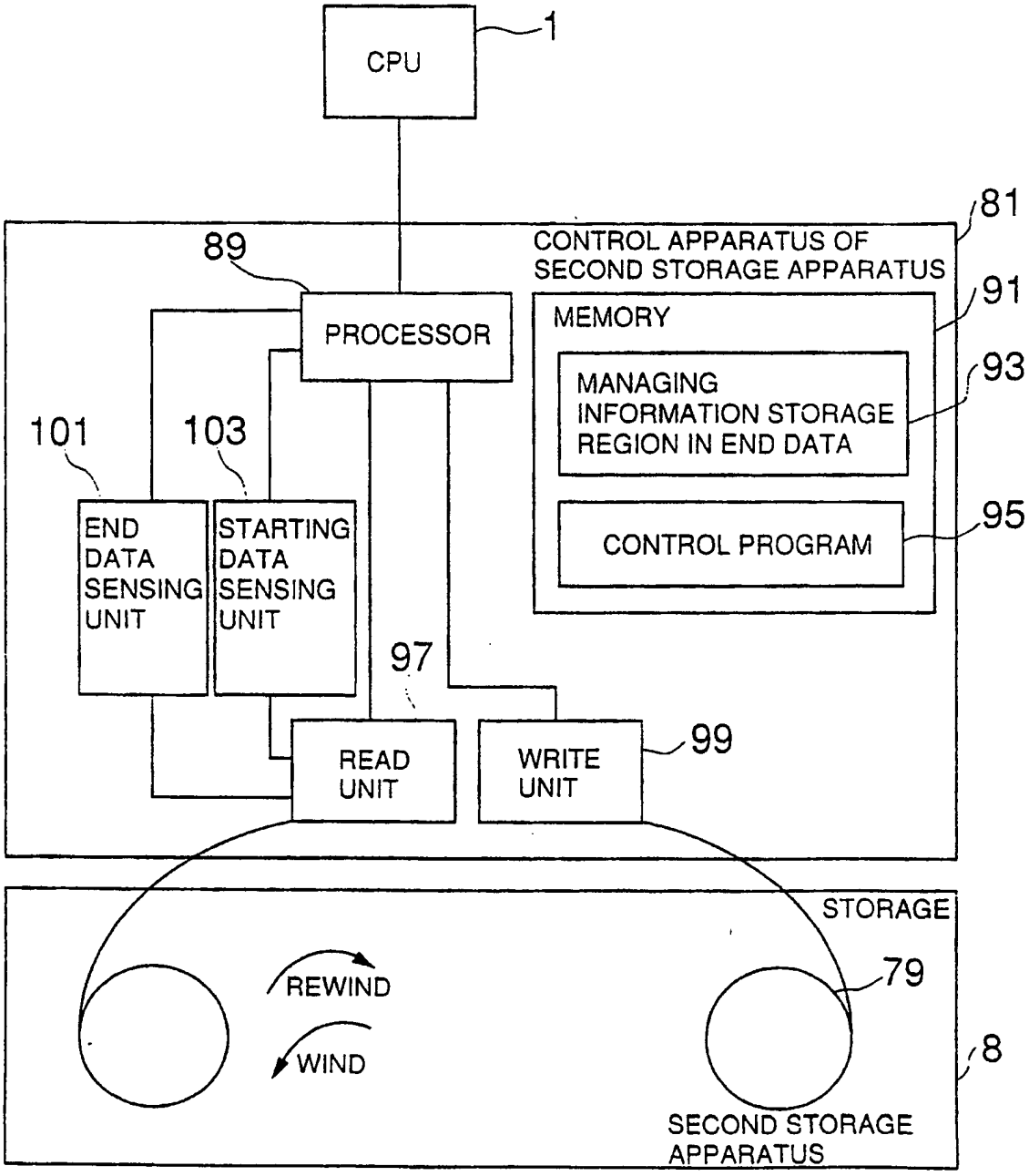


FIG. 15

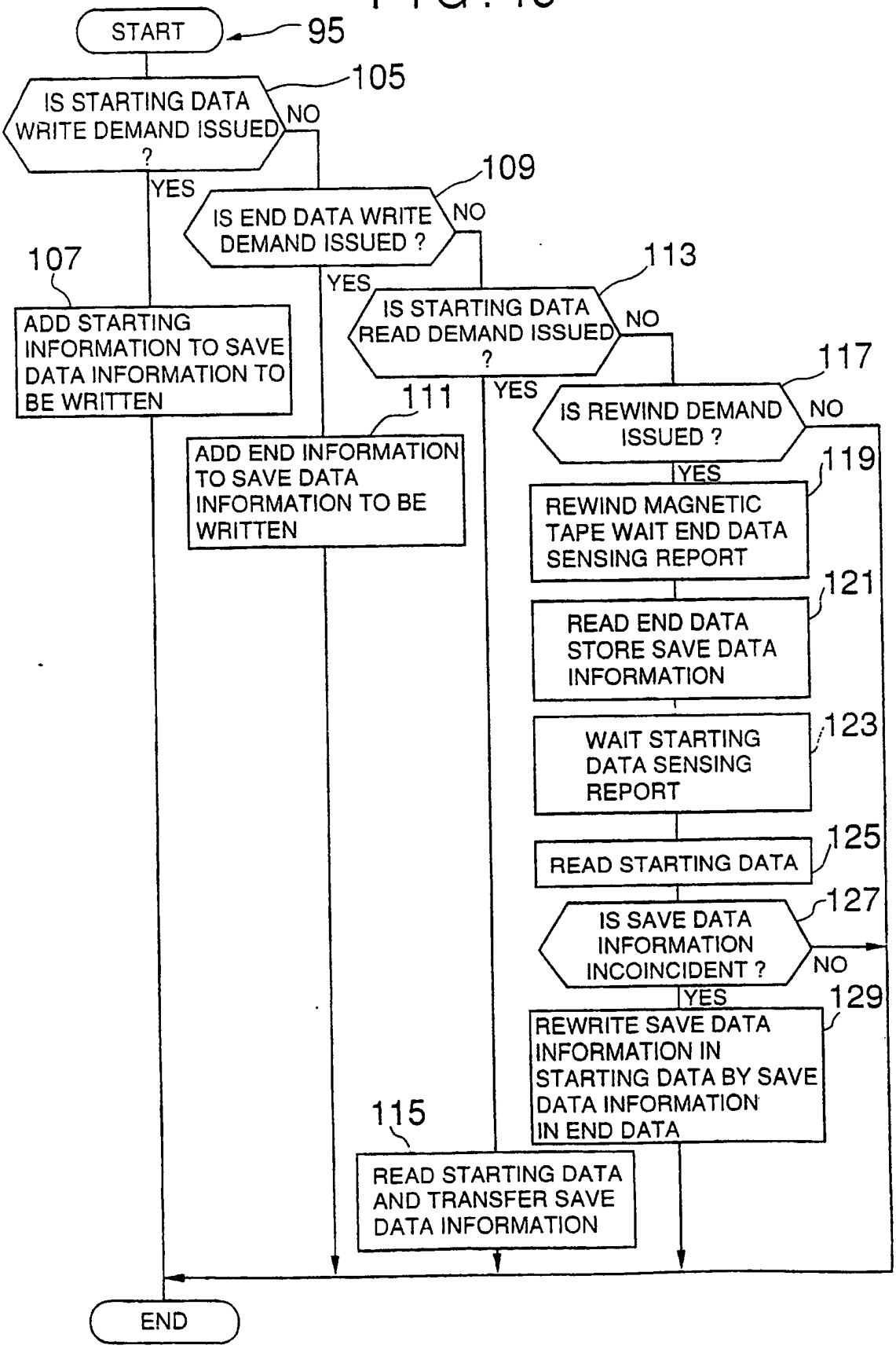


FIG.16

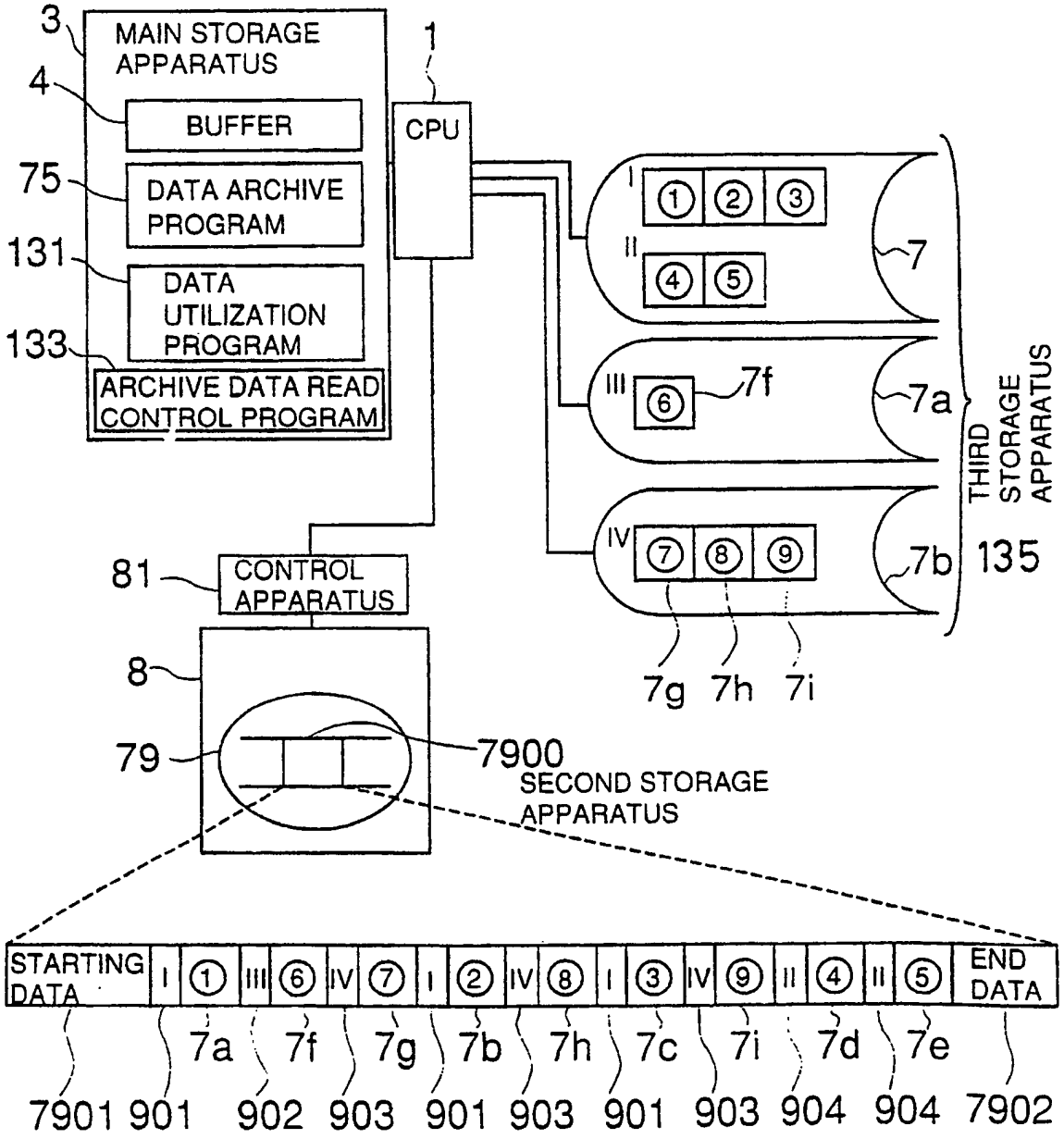

3
MAIN STORAGE APPARATUS
4
BUFFER
75
DATA ARCHIVE PROGRAM
131
DATA UTILIZATION PROGRAM
133
ARCHIVE DATA READ CONTROL PROGRAM
1
CPU
I
II
III
IV
7
7a
7b
7f
7g
7h
7i
THIRD STORAGE APPARATUS
135
81
CONTROL APPARATUS
8
79
7900
SECOND STORAGE APPARATUS
STARTING DATA
END DATA
7901
901
902
903
901
903
901
903
904
904
7902

FIG. 17

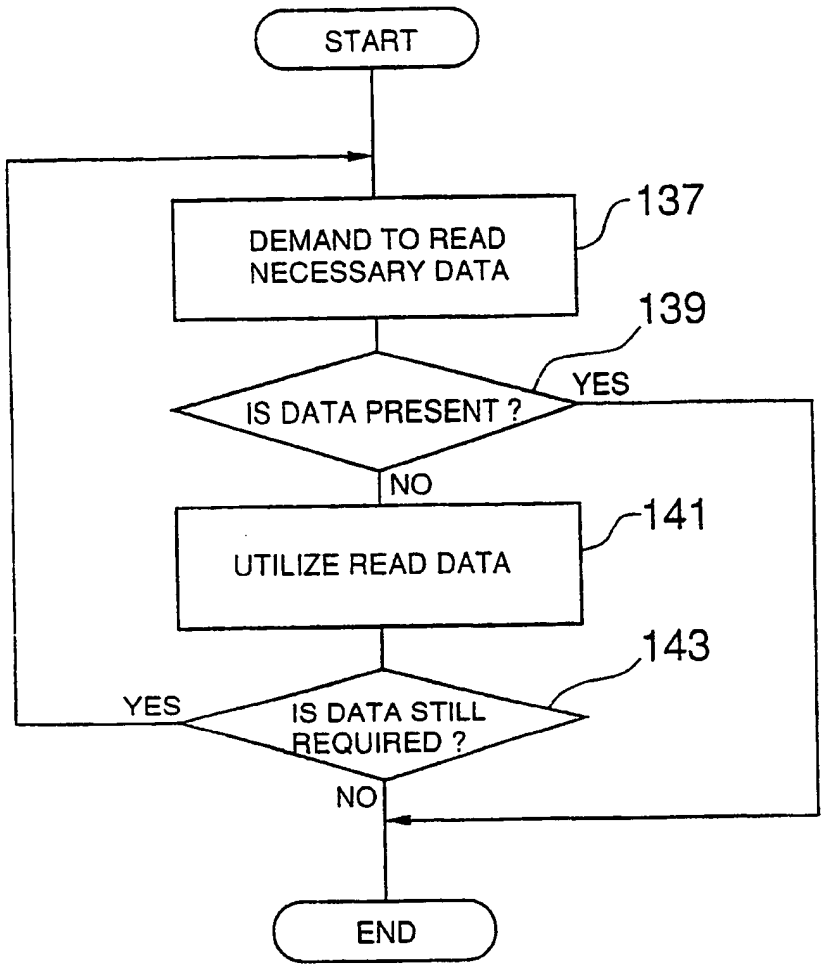

START
DEMAND TO READ NECESSARY DATA
137
IS DATA PRESENT ?
139
YES
NO
UTILIZE READ DATA
141
IS DATA STILL REQUIRED ?
143
YES
NO
END

FIG. 18

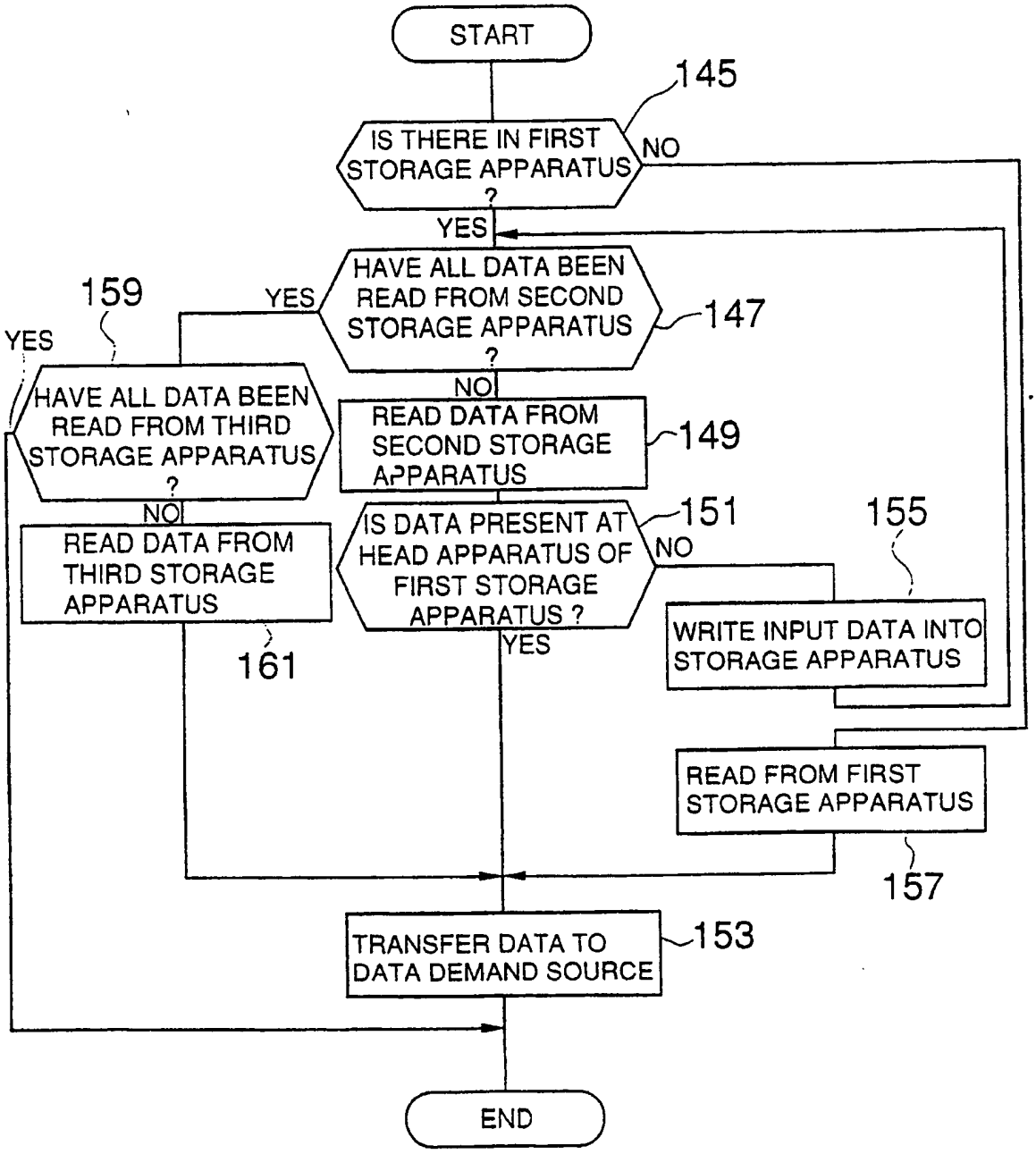

START
145
IS THERE IN FIRST STORAGE APPARATUS ?
NO
YES
HAVE ALL DATA BEEN READ FROM SECOND STORAGE APPARATUS ?
147
YES
159
YES
HAVE ALL DATA BEEN READ FROM THIRD STORAGE APPARATUS ?
NO
READ DATA FROM SECOND STORAGE APPARATUS
149
IS DATA PRESENT AT HEAD APPARATUS OF FIRST STORAGE APPARATUS ?
151
NO
155
YES
READ DATA FROM THIRD STORAGE APPARATUS
161
WRITE INPUT DATA INTO STORAGE APPARATUS
READ FROM FIRST STORAGE APPARATUS
157
TRANSFER DATA TO DATA DEMAND SOURCE
153
END

FIG. 19

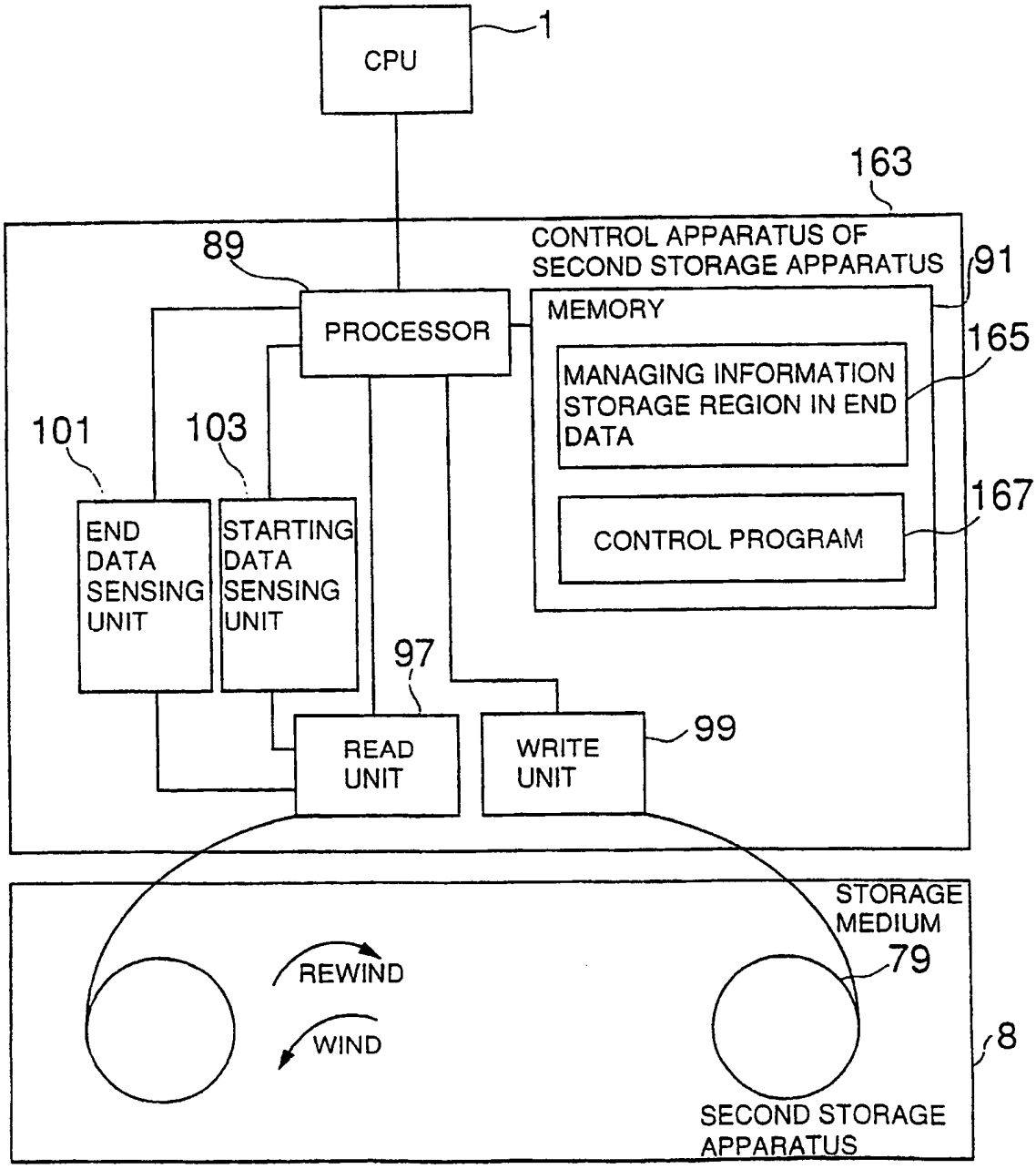

CPU
1
163
CONTROL APPARATUS OF SECOND STORAGE APPARATUS
89
91
PROCESSOR
MEMORY
165
MANAGING INFORMATION STORAGE REGION IN END DATA
101
103
167
CONTROL PROGRAM
END DATA SENSING UNIT
STARTING DATA SENSING UNIT
97
99
READ UNIT
WRITE UNIT
STORAGE MEDIUM
79
REWIND
WIND
8
SECOND STORAGE APPARATUS

FIG. 20

(a)

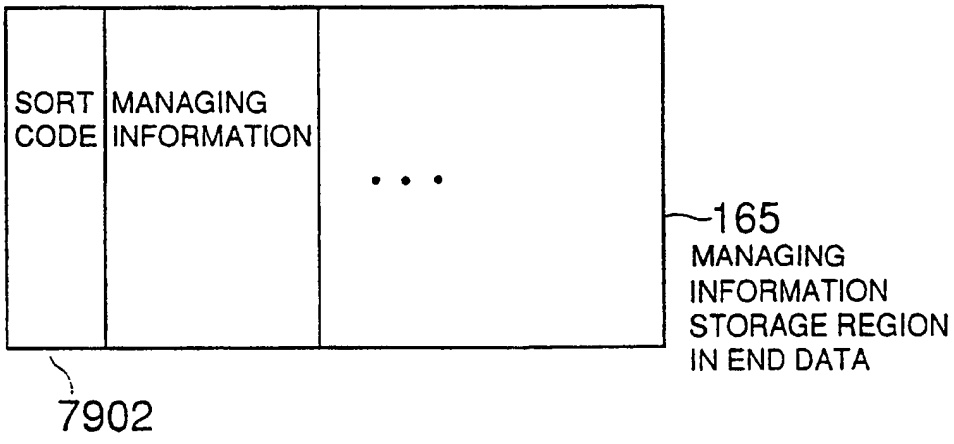

SORT CODE
MANAGING INFORMATION
• • •
165
MANAGING INFORMATION STORAGE REGION IN END DATA
7902

FIG. 20

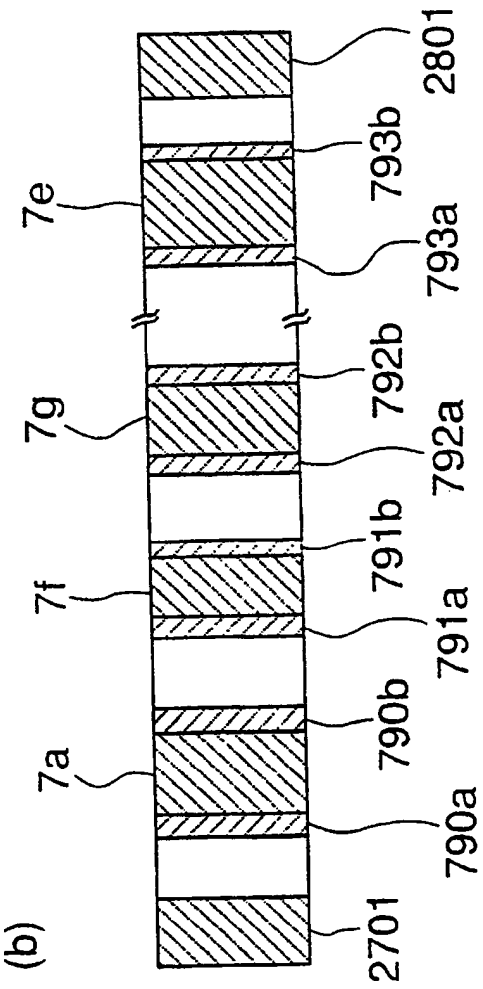


FIG. 21

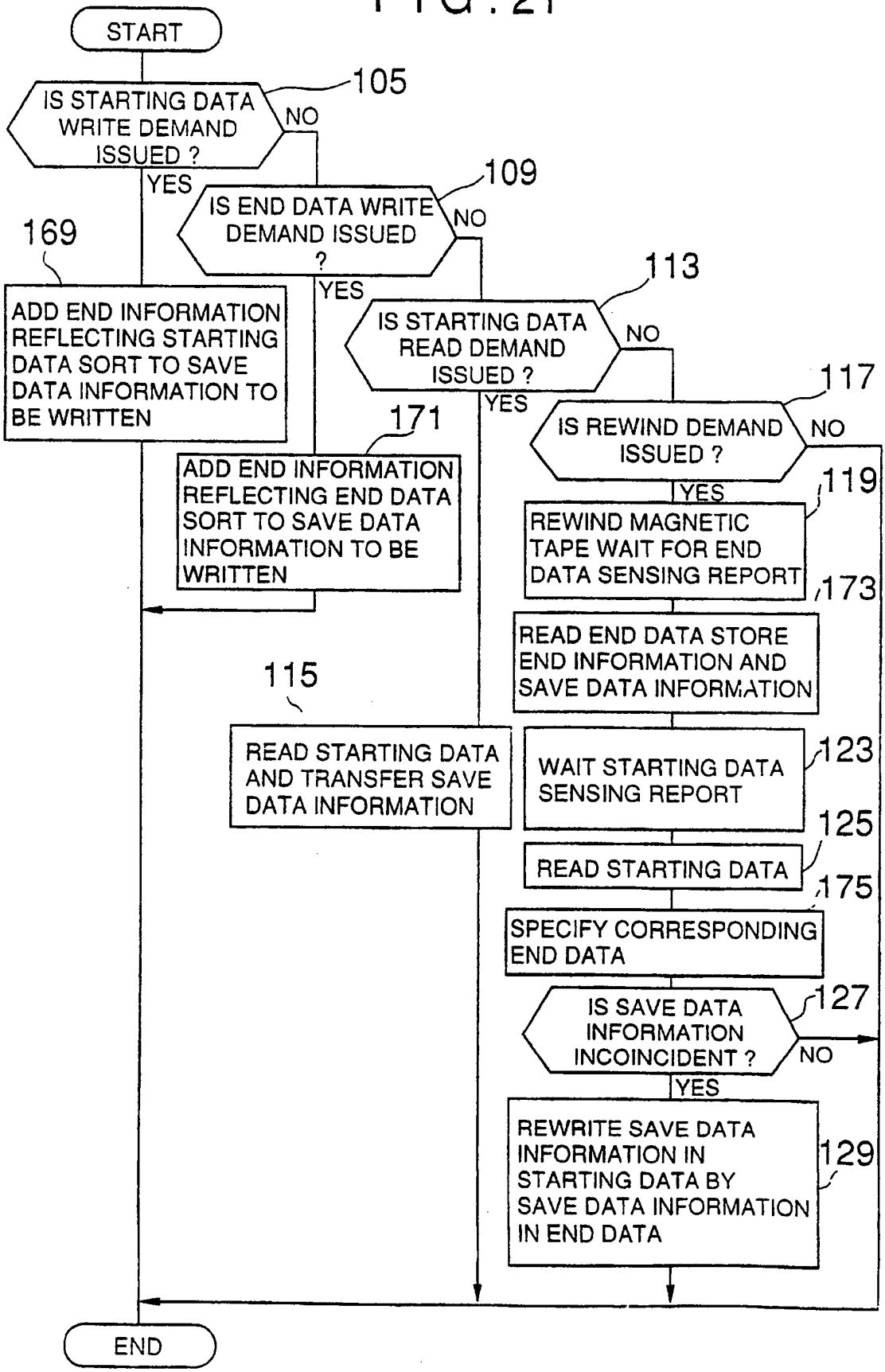

START
IS STARTING DATA WRITE DEMAND ISSUED ?
105
NO
YES
IS END DATA WRITE DEMAND ISSUED ?
109
NO
YES
169
ADD END INFORMATION REFLECTING STARTING DATA SORT TO SAVE DATA INFORMATION TO BE WRITTEN
IS STARTING DATA READ DEMAND ISSUED ?
113
NO
YES
171
ADD END INFORMATION REFLECTING END DATA SORT TO SAVE DATA INFORMATION TO BE WRITTEN
IS REWIND DEMAND ISSUED ?
117
NO
YES
REWIND MAGNETIC TAPE WAIT FOR END DATA SENSING REPORT
119
READ END DATA STORE END INFORMATION AND SAVE DATA INFORMATION
173
115
READ STARTING DATA AND TRANSFER SAVE DATA INFORMATION
WAIT STARTING DATA SENSING REPORT
123
READ STARTING DATA
125
SPECIFY CORRESPONDING END DATA
175
IS SAVE DATA INFORMATION INCOINCIDENT ?
127
NO
YES
REWRITE SAVE DATA INFORMATION IN STARTING DATA BY SAVE DATA INFORMATION IN END DATA
129
END

FIG. 22

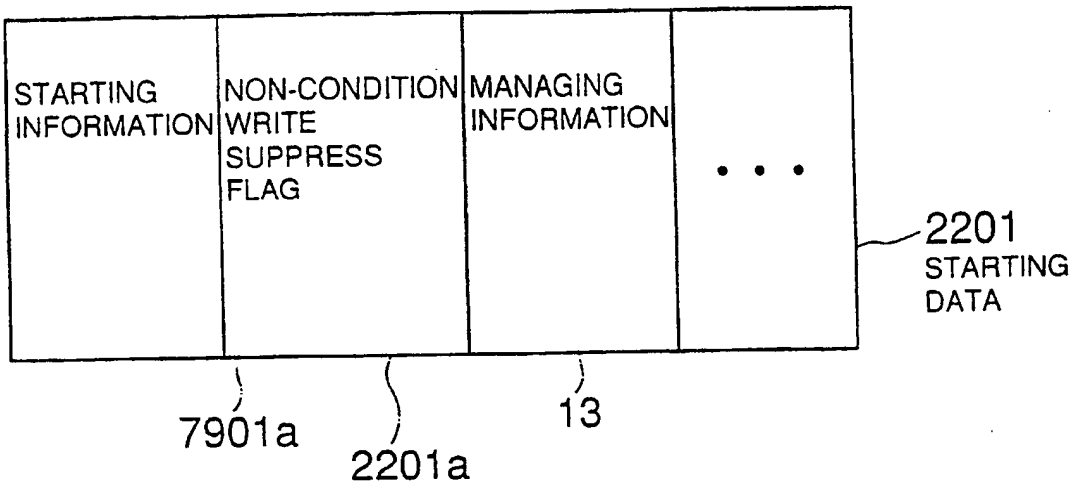

STARTING INFORMATION
NON-CONDITION WRITE SUPPRESS FLAG
MANAGING INFORMATION
• • •
2201
STARTING DATA
7901a
2201a
13

FIG. 23

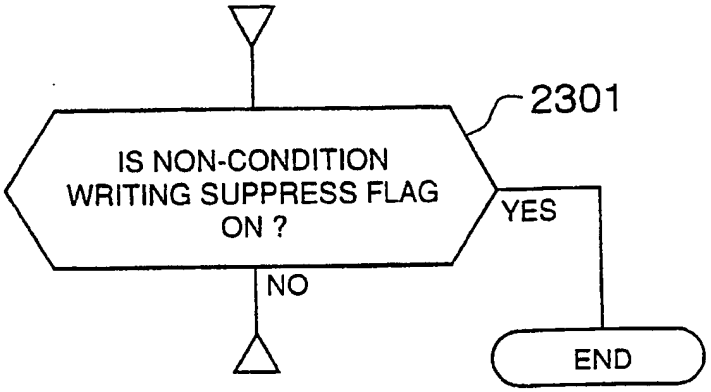

2301
IS NON-CONDITION WRITING SUPPRESS FLAG ON ?
YES
NO
END

FIG. 24

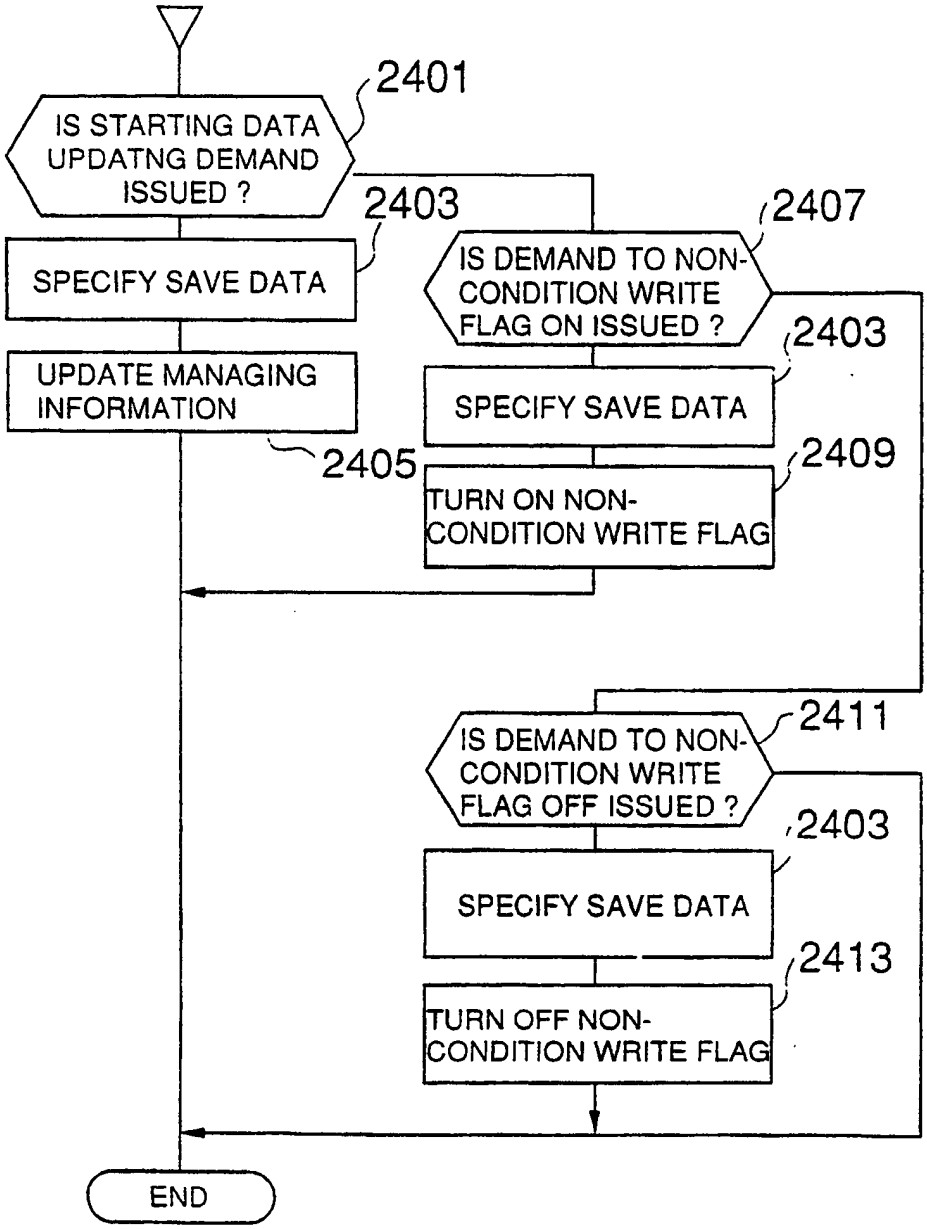

2401
IS STARTING DATA UPDATNG DEMAND ISSUED ?
2403
SPECIFY SAVE DATA
UPDATE MANAGING INFORMATION
2405
2407
IS DEMAND TO NON-CONDITION WRITE FLAG ON ISSUED ?
2403
SPECIFY SAVE DATA
2409
TURN ON NON-CONDITION WRITE FLAG
2411
IS DEMAND TO NON-CONDITION WRITE FLAG OFF ISSUED ?
2403
SPECIFY SAVE DATA
2413
TURN OFF NON-CONDITION WRITE FLAG
END

FIG. 25

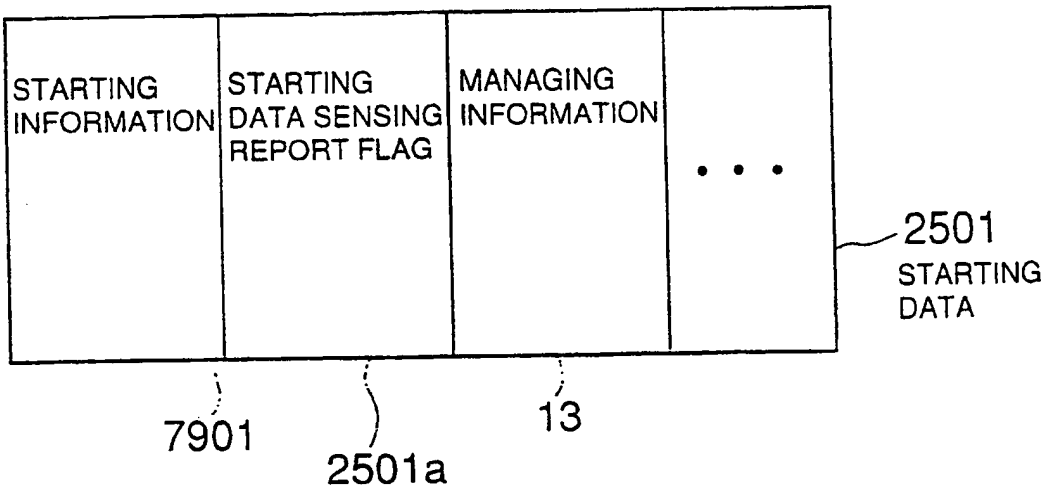

STARTING INFORMATION
STARTING DATA SENSING REPORT FLAG
MANAGING INFORMATION
• • •
2501
STARTING DATA
7901
2501a
13

FIG. 26

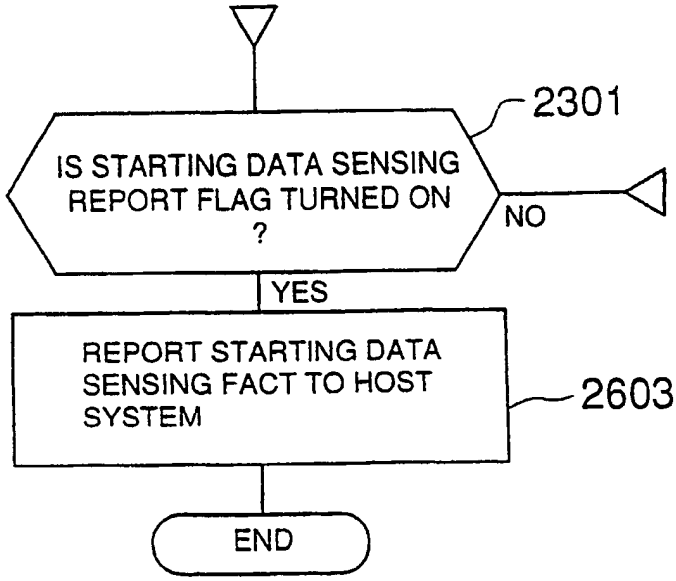

2301
IS STARTING DATA SENSING REPORT FLAG TURNED ON ?
NO
YES
REPORT STARTING DATA SENSING FACT TO HOST SYSTEM
2603
END

FIG. 27

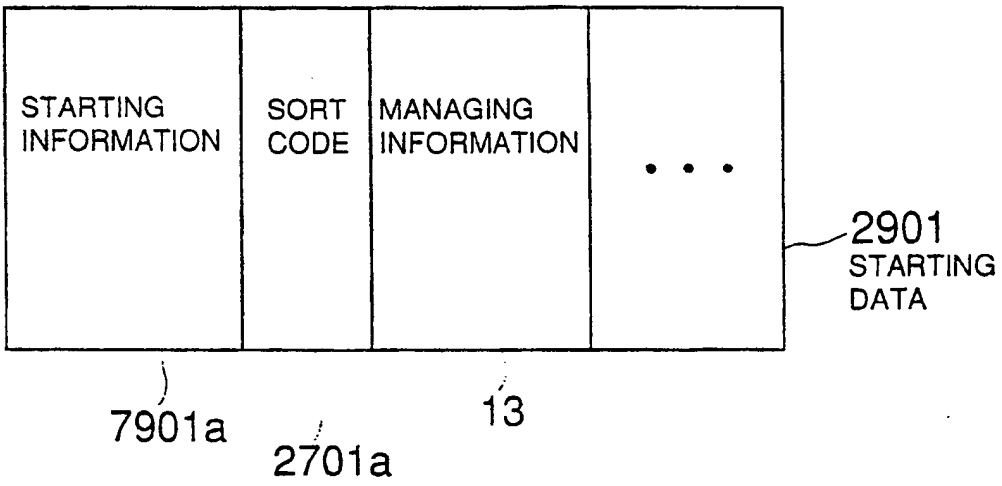
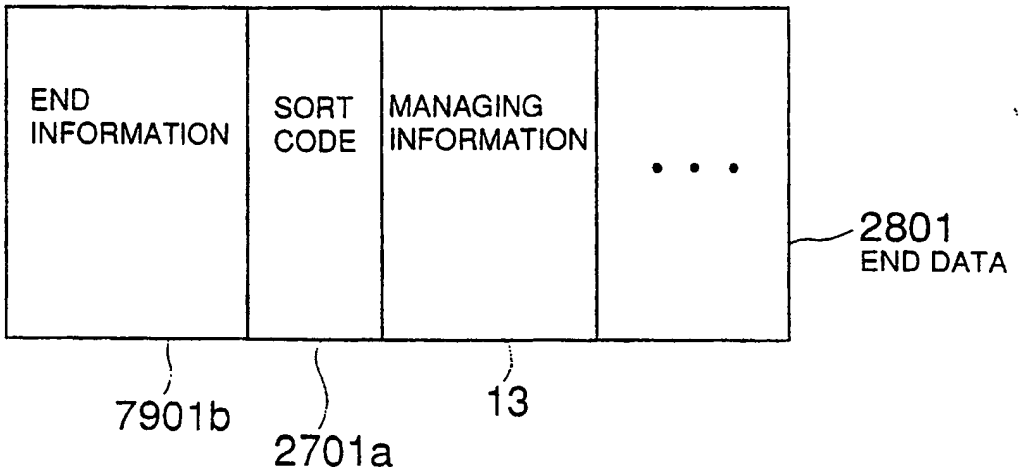

STARTING INFORMATION
SORT CODE
MANAGING INFORMATION
• • •
2901
STARTING DATA
7901a
2701a
13

FIG. 28


END INFORMATION
SORT CODE
MANAGING INFORMATION
• • •
2801
END DATA
7901b
2701a
13

STORAGE CONTROL METHOD AND APPARATUS

The present invention relates to a storage control method for storing data, which have been stored in a plurality of storage apparatuses, into a sequentially accessible second storage apparatus and a control apparatus therefor.

A magnetic disk apparatus, an optical disk apparatus, a magneto-optic disk apparatus, and a magnetic drum apparatus, or the like has been conventionally employed as a storage apparatus for storing data therein. To assure reliability of the data which have been stored in such a storage apparatus, there is a method for storing the same data also into another backup storage apparatus. In this case, the same data are stored in both of the original storage apparatus and the backup storage apparatus (backup purpose), i.e., the data storage operation is performed twice. Also, to achieve an effective utilization of the original storage apparatus, there is another method for saving the data into the backup storage apparatus. In any methods, the data can be restored into the original storage apparatus, if required.

For better understanding of the following explanation, storing of data into another specific storage

apparatus will be referred to as "archive". When a series of data to be archived have been stored in a plurality of storage apparatuses an archive operation will be carried out as follows. One from among the plurality of storage apparatuses in which the series of data to be saved or archived have been stored, is selected in a data arranging sequence (a meaningful sequence), and data within the selected storage apparatus is saved to the specific storage apparatus. When the archive of the series of data in this specific storage apparatus have been completed, a storage apparatus is newly selected from among the storage apparatuses and the series of data stored therein are archived. As described above, in a conventional method, the series of data have been successively archived from the plurality of storage apparatuses into the specific storage apparatus.

A storage control unit of a second (another specific) storage apparatus issues a command for performing either a data writing operation (data writing operation for archiving the series of data), or a data reading operation for a storage medium of the second storage apparatus, to a host system (computer) which connects a first (original) storage apparatus group thereto, and this command is executed by the host system so as to archive or restore the series of data. Thus, although a writing or reading command for the series of data are prepared in the second storage apparatus, no commands to write, read or copy (overwrite) managing

information concerning the series of data, which are held by the host system, have been prepared. As a result, when the series of data are archived from the first storage apparatuses to the second storage apparatus, the host system must record and read the managing information as a part of the data, in the prior art.

Such a sort of technical idea has been described in, for instance, HITAC VOS 2/VOS 3 Utility 1st volume (system utility/independent utility) 8080-3-302.

Furthermore, in accordance with JP-A-2-56648, there is described that the information required for restoring the data is prepared as the managing information when the data are archived.

An object of the present invention is to provide a storage control method capable of shortening a time period for archive when series of data are saved or archived from first storage apparatuses into a second storage apparatus, which has high performance and can be exclusively and sequentially accessed, and also capable of writing managing information concering the series of data at a position previous to the series of data, without repeating rewind and wind operations of a storage medium and an apparatus therefor.

Such an object has been set based on the following recognition of conventional problems.

(a). In the prior art, as previously described,

the data saving method is performed in such a manner that when the series of data are saved from a plurality of first storage apparatuses into a second storage apparatus which is exclusively and sequentially accessible and has an access speed or rate extremely faster than that of any one of the first storage apparatuses, data is read out from one among the plural first storage apparatuses and then written into the second storage apparatus. After the data have been completely saved, next data is read out from a next one among the first storage apparatuses and then are written into the second storage apparatus. As a consequence, the time required for saving all of the series of data depends upon only the access rate of the first storage apparatus even if each first storage apparatus has a very high access rate.

(b). If such a method would be employed wherein the number of second storage apparatuses is prepared to be equal to the number of first storage apparatuses and each data are independently saved in parallel, the processing speed becomes very high. However, since a plurality of second storage apparatuses are exclusively utilized in this method, other job service must be waited and long time and high cost are required for managing the storage mediums of the second storage apparatuses.

(c). In case that the series of data are saved in the sequential-accessible second storage apparatus such as a magnetic tape, when the stored data are read out to

be utilized, it is very convenient if managing information (a length of each data, a storage position of the data, a title of the data, and the number of an apparatus in which the data has been stored) about the series of data is provided at the heat position of the series of data. However, since the managing information is recorded after the series of data have been completely written, such managing information needs to be written after recording the series of data and rewinding the storage medium to the head position thereof. Then, in order to subsequently use this storage apparatus, since such a mechanical operation for winding the storage medium from the head position thereof to the end position of the recorded data again is required, the subsequent job must be waited during this mechanical operation because the storage apparatus cannot be used.

In addressing the above problems, the storage control method according to the present invention may provide (i) reading each of series of data in a plurality of storage units of a first storage apparatus, adding to the read data, an identifier for specifying one of consecutive areas within a storage unit in which the data have been stored, and writing the series of data inputted from the first storage apparatus into the second storage apparatus during at least one access operation and also repeating of this writing operation.

(ii). The present invention may provide that if an amount of data inputted from the first storage

apparatus is smaller than an amount of data outputted to the second storage apparatus and the input buffers corresponding only to the remaining data are prepared when the respective data are read from the first storage apparatus in parallel, the number of storage units of the first storage apparatus for performing the read operation is limited in such a way that an amount of archive data which are read from the respective storage units per unit time is reduced within a range of such an amount of data writable within the above-described unit time.

(iii). The present invention may propose that the identifier for specifying one of the consecutive storage areas within each storage unit also contains a value indicative of a sequential relation among the identifiers.

(iv). The present invention may also propose that when the series of data saved into the second storage apparatus are to be utilized, only the data having the identifier for specifying one of the consecutive storage areas within the first storage apparatus where the series of data has been stored at first, is selected and processed. The remaining data are once stored into the directly accessible third storage apparatus, and after all of the series of data saved in the second storage apparatus have been read out, the remaining data in the third storage apparatus are read into the buffer region in an arrangement order and are processed.

(v). In a method for restoring a series of archive data saved in the second storage apparatus to the third

storage apparatus, the present invention may provide that the identifiers for specifying consecutive storage areas of storage units in the first storage apparatus and also the storage sizes for all the series of archive data are read, new storage areas corresponding to the storage areas and the storage sizes when a series of data corresponding to the series of archive data are present in the storage units of the first storage apparatus, are allocated to storage units in the third storage apparatus, the number of which is equal to that of the storage units in the first storage apparatus. Then, the series of archive data read out from the second storage apparatus are written into the storage units of the third storage apparatus based upon the identifiers added to these data.

(vi). The present invention may also provide that a series of data are saved in the second storage apparatus in such a manner that managing information about the overall storage areas in which the series of data have been stored within the first storage apparatus, is added just before and just after the series of saved or archive data. A starting section constructed of at least starting information which is for sensing a portion immediately before the series of archive data and managing information related to the series of archive data is recorded just before the series of archive data, whereas an end section constructed of at least end information for sensing a portion immediately after the series of archive data and the managing information about them is recorded just after

the series of archive data. When the second storage apparatus is rewound, both the starting information and the end information are sensed and then the end section managing information is overwritten on the starting section managing information.

(vii). The present invention may also provide that a plurality of combinations of the starting information and end information have been set to the storage medium of the second storage apparatus. The end section managing information about the series of archive data is stored in correspondence with the end information. When the starting information is sensed during the rewind operation of the storage medium, the end information corresponding to the sensed starting information is selected from among the plurality of combinations and the managing information corresponding to the selected end information is overwritten on the starting section managing information.

(viii). The present invention may have the feature that when the starting section managing information is written, the overwrite suppression flag of the end section managing information into the start section managing information is also written. Thus, when the starting information is sensed, a selection is made based upon this overwrite suppression flag, whether or not the process for over-writing the end section managing information is to be performed.

(ix). The present invention may also provide that when the starting section managing information is written,

a flag to determine whether or not a report for informing sensing of the starting section is required is also written. When the starting information is sensed, a selection is made based on the content of this flag whether or not the sensing report to a host system is to be performed.

(x). The storage control apparatus according to the present invention may further employ in the main storage apparatus, a buffer region for reading the series of archive data in parallel from the first storage apparatus, and a data saving module for adding an identifier for specifying an area for each archive data in the first storage apparatus, to the archive data read into the buffer region, and for writing the series of archive data with the identifiers into the second storage apparatus.

(xi). The present invention may also employ in the main storage apparatus, a buffer region for reading the series of archive data in parallel from said first storage apparatuses a first control module for selecting only archive data having identifiers for specifying consecutive areas in the first storage apparatus, where a first arrangement of the series of archive data has been stored from among the series of archive data read into said buffer region, for transferring the selected archive data to an utilization module, and for storing the remaining archive data once into a directly accessible third storage apparatus; and a

second control module for reading the archive data stored in the third storage apparatus into the buffer region in an arrangement sequence of the series of archive data.

(xii). Furthermore, the present invention may employ in a control apparatus of the second storage apparatus, a control module for recording a starting section constructed of at least starting information for sensing the starting section and managing information and an end section constructed of at least end information for sensing the end section and managing information, and control module for reading the starting section managing information, and for sensing both the starting information and the end information during a rewind operation of said second storage apparatus so as to make the starting section managing information coincident with the end section managing information.

In accordance with the present invention, (i) the data may be parallel-written from the plural first storage apparatuses into the second storage apparatus; (ii) during this data writing operation, an identifier for specifying an area of the first storage apparatuses is added thereto; (iii) the managing information related to the archive data is written into a portion immediately after the archive data and is copied at a portion immediately before the archive data during the rewind operation; and, (iv) when the data are restored, the third storage apparatus is allocated as the restore source, and also the data are written into the third storage apparatus

based on the identifying data. As a consequence, the data saving time can be shortened as compared to the conventional data saving time. Also, the managing information on the series of archive data can be written at the portion of immediately before the data with a simple operation, and also the waiting time for the job to utilize the second storage apparatus can be shortened, furthermore, when the series of archive data are utilized, since the data are once stored in the directly accessible third storage apparatus, an increase in the reading time required for restoring the data may be prevented.

The objects and features of the invention will best be understood from a detailed description of preferred embodiments thereof, selected for purposes of illustration and shown in the accompanying drawings, in which:

Fig. 1 is an overall arrangement of a data archive and restore system for showing a first embodiment of the present invention;

Fig. 2 is a logic arrangement diagram of managing information on archive data in Fig. 1;

Fig. 3 is a flowchart for representing a process of a data archive program in Fig. 1;

Fig. 4 is a flowchart for explaining a process of a data restore program in Fig. 1;

Fig. 5 is an overall arrangement diagram of a data archive restore system for showing a second embodiment of the present invention;

Fig. 6 is a logic arrangement diagram of starting data in Fig. 5;

Fig. 7 is a flowchart for showing a process of a data archive program in Fig. 5;

Fig. 8 is a flowchart for representing a process of a data restore program in Fig. 5;

Fig. 9 is an overall constructive diagram of a data archive restore system for representing a third embodiment of the present invention;

Figs. 10 and 11 are logic arrangement diagrams of starting data and end data in Fig. 9;

Fig. 12 is a flowchart for showing a process of a data archive program in Fig. 9;

Fig. 13 is a flowchart for representing a process of a data restore program in Fig. 9;

Fig. 14 is a constructive diagram for showing a control apparatus of a data save destination storage apparatus in Fig. 9;

Fig. 15 is a flowchart for showing a process of a control program in Fig. 14;

Fig. 16 is an overall constructive diagram of a data archive restore system for showing a fourth embodiment of the present invention;

Fig. 17 is a flowchart for showing a data utilization program in Fig. 16;

Fig. 18 is a flowchart for representing a process of a data read control program in Fig. 16;

Fig. 19 is a constructive diagram of a control apparatus for a data save destination storage apparatus for showing a fifth embodiment of the present invention;

Fig. 20 is a logic constructive diagram of a managing information storage region within end data in Fig. 19, and also an illustration of a storage medium of a second storage apparatus having starting/end data on a nest;

Fig. 21 is a flowchart for showing a process of a control program in Fig. 19;

Fig. 22 is a logic constructive diagram of starting data according to a modification of the third embodiment shown in Fig. 9;

Fig. 23 is a flowchart for explaining a process of a partial addition in a modification of the control program of Fig. 14;

Fig. 24 is a flowchart of a partial process for showing a modification of the control program in Fig. 14;

Fig. 25 is a logic constructive diagram for showing a modification of the starting data in Fig. 9;

Fig. 26 is a flowchart of a partial addition process for representing a modification of the control program in Fig. 14;

Fig. 27 is a logic constructive diagram for showing a modification of the starting data in the fifth embodiment of Fig. 19; and,

Fig. 28 is a logic constructive diagram for representing a modification of the end data in Fig. 19.

Referring now to the drawings, preferred embodiments of the present invention will be described in detail.

Fig. 1 is a block diagram showing an overall arrangement of a data archive (save) and restore system according to a first preferred embodiment of the present invention.

Reference numeral 1 indicates a central processing apparatus (CPU) for controlling a main storage apparatus and a first storage apparatus. Reference numeral 3 indicates a main storage apparatus for storing therein a program executed by CPU and data used to execute this program. Reference numeral 7 denotes the first storage apparatus including storage units such as magnetic disk apparatuses, magneto-optic disk apparatuses, magnetic tape apparatuses, or the like into which data to be saved (archived) has been stored. The storage units in the first storage apparatus correspond to files. Reference numeral 13 represents a magnetic disk apparatus for storing therein managing information on a series of archive data. According to this embodiment, there are provided in the main storage apparatus; a buffer area 4 for temporarily storing data; a storage region 5 for a program for saving the data stored in the first storage

apparatus, and a storage region 6 for a program for restoring this data into the first storage apparatus.

A storage apparatus for storing a series of archive data is constructed of a control apparatus 11, a second storage apparatus 8 as the destination for the archive data; and a storage medium 9, which is typically of a magnetic tape, for sequentially writing and reading data. Although Fig. 1 represents that the control apparatus 11 is arranged outside the second storage apparatus 8, this control apparatus 11 may be alternatively built in the apparatus 8. A portion indicated by a dot line of this figure is an enlarged view of the magnetic tape.

For the sake of simple explanation, in a case that data are saved from the first storage apparatus 7 into the second storage apparatus 8, a series of data an amount of data per a transfer cycle which is transferred in accordance with the data archive program 5 are indicated by ① to ⑨. Also, the storage areas of the series of data are indicated by 7a to 7i. The respective storage areas 7a to 7c, 7d and 7e, 7f, and 7g to 7i are represented by regions I, II, III and IV. The storage regions I and II are present in the same storage unit.

From different point of view, the data stored in the first storage apparatus will now be explained as follows:

Each of numbers ① to ⑨ indicates data corresponding to a data size when the data is read from or

written in the first storage apparatus. Accordingly, the whole numbers ① to ⑨ represent a series of data having a meaning. Therefore, a sequence of the numbers ①, ②, ..., ⑨ implies the series of data.

It is assumed that the access speed or rate of the second storage apparatus 8 is extremely faster than that of the first storage apparatus 7, and also the series of data to be moved have been divided and stored into the plurality of storage units as the first storage apparatus 7. In this case, this embodiment has such a feature that the CPU 1 reads out the data stored in the first storage apparatus 7 from these storage units in parallel, an identifier indicative of one of the storage units in which one of the read data has been stored is added to this read data, and also the data with the identifier is stored (saved) in the second storage apparatus 8.

As a result, since the better access performance of the second storage apparatus 8 is available, the time required to save the series of data may be shortened.

A series of archive data 900 will be written on the storage medium 9 within the second storage apparatus 8 as follows. The data ①, ⑥ and ⑦ are read out from the first storage apparatus 7 in parallel at a first read operation and are stored with the identifiers I (901), III (902) and IV (903) given for the respective storage areas. Subsequently, the data ② and ⑧ are read out in parallel at a second read operation and are similarly

stored with the identifiers I (901) and IV (903). Next, the data ③ and ⑨ are read out in parallel at a third read operation and are similarly stored with the identifiers I (901) and IV (903). Then, the data ④ is read at a fourth read operation and stored with the identifier II (904). Finally, the data ⑤ is read out at a fifth read operation and stored with the identifier II (904).

It should be noted that an identifier is constructed of a symbol for specifying a name of any one of the storage units in the first storage apparatus 7, and also another symbol for specifying any one of the continuous storage areas within the storage unit.

Fig. 2 represents a data storage state of a storage apparatus for storing managing information 13 in Fig. 1. As shown in Fig. 2, the managing information 13 related to the archive data is constructed of a name of a file 1300 to be saved, and a pair of an identifier 1301 and an area size 1302 for each storage area of the storage apparatus. Furthermore, the identifier 1301 is constructed of name 1301a of one storage unit in the first storage apparatus 7 and sequence number 1301b which is attached to one of the continuous storage areas of the storage unit in accordance with the data storage sequence (namely, a sequence number of one of the areas within the first storage unit). It should be noted that when there are a plurality of storage areas for the series of archive data, pairs of the identifier 1301 and the area size 1302 are

present in a storage sequence of the archive data. Further, the construction of the identifier may be modified if this modified identifier can specify the sequence relation between the continuous storage areas and the archive data.

Fig. 3 is a flowchart for explaining processing of the data archive program in Fig. 1. In Fig. 1, to save the data which have been separated and stored in the first storage apparatus 7, the CPU 1 reads out and executes the data archive program 5 stored in the main storage apparatus 3.

Upon initiation of the data archive program 5, presence, a number and a sequence of each of the consecutive areas within the first storage apparatus are obtained to determine identifiers for the consecutive areas (a step 15). Next, a data input buffer 4 for the respective areas is prepared (a step 17). The number of storage units in the first storage apparatus 7 is set to a counter N (a step 19). In case of Fig. 1, "N" is equal to "3". It should be noted that a maximum value of N does not exceed a ratio of an access rate or speed of the second storage apparatus 8 to that of the first storage apparatus 7.

For instance, when the access rate of the second storage apparatus 8 is 10 times higher than that of the first storage apparatus 7, the maximum value of N does not exceed "10". It should be also noted that if the archive data is compressed when the archive data is saved into the

second storage apparatus 8, the maximum value of N is to be set, taking account of the presumed compression value. When, for instance, the access rate ratio is 5 and the compression ratio is 1/3, the maximum value of N is selected to be a value which does not exceed "15". In case that the access rates of the storage units in the first storage apparatus 7 is not equal to each other, namely the first storage apparatus 7 contains even one storage unit having a different access rate from those of other storage units, it may be determined that a summation of these access rates does not exceed the access rate of the second storage apparatus 8. It is of course that if the data amount from the CPU 1 to the second storage apparatus 8 is smaller than that from the first storage apparatus 7 to the CPU 1, the value of "N" may be selected to be large or small, considering the memory capacity of the buffer region 4 within the main storage apparatus 3 for storing the remaining data.

Subsequently, "1" is set to the counter I for determining the sequence of storage units in the first storage apparatus 7 (a step 21), and a check is made whether or not there is data at a certain area within the I-th storage unit of the first storage apparatus (a step 23). When there is no archive data, if the next value of I is not greater than N, the number of I is updated by the next value (steps 27 and 29). When there is the archive data, since any storage unit to which an input request is not yet issued is present in the first storage apparatus

7, the input request is issued for transfer in a unit of a single block (a step 25). "1" is added to the counter I (a step 29), and then the process returns to the step 23 at which the above-described process is repeated. It should be understood that the single block implies a transfer unit such as one cylinder unit, one track unit and one sector unit in case of a magnetic disk apparatus.

When "1" is added and thus I becomes greater than N (a step 27), the process is set to a waiting state until the series of archive data are inputted from the first storage apparatus 7 into the buffer region 4 (a step 31). That is, the data archive program 5 successively issues the input requests to storage units in the first storage apparatus 7, and judges whether or not all of responses have been obtained from the storage units to which the input requests have been issued (a step 33). If all the responses are not yet obtained, the process returns to the step 31 at which the waiting process is repeated. In view of the program, a series of processes as defined at the steps 25, 31 and 33 indicate such operations that when the input requests are issued to the storage units in the first storage apparatus 7, it waits until all end reports (i.e., responses to the input requests) are received, and when the end reports are received from the storage units in the first storage apparatus 7, the requested archive data have been stored in the buffer region 4. In other words, the archive data are read in parallel in view of the program. Although the

practical input operation is omitted in the drawing, it depends on channel operations.

When the responses are obtained, an identifier for specifying the storage area of each archive data is added to the archive data, and then the resultant data are written into the second storage apparatus 8 (a step 35). In this case, the archive data may be compressed or may not be compressed.

Next, a check is made whether the whole archive data have been saved into the second storage apparatus 8 (a step 37). If all of the archive data have not yet been saved, the process returns to the step 21 at which the subsequent process is repeated. To the contrary, when all of the archive data have been saved, the respective area sizes and identifiers, and the like are registered in the managing information file 13 (a step 39). As a result, the process of this program is accomplished.

Fig. 4 is a flowchart for showing a process of a data restore program in Fig. 1. When a data restore program 6 is initiated, the managing information such as the respective area sizes and identifiers is first inputted from the managing information file 13 (a step 41). Restore destination storage areas in correspondence to the number of storage areas and the storage area sizes before the save operation are allocated to restore destination storage units (a step 43). In this case, the restore destination storage units may be equal to those in the first storage apparatuses 7, or in another storage

apparatus different from the first storage apparatus 7. If the consecutive storage areas are assigned to the storage units in the first storage apparatus 7 before the save operation, they may be assigned as the restore destination storage apparatus to the same storage units but some storage areas may be combined with each other to be assigned to an identical storage unit.

It should be noted that although managing workload when some storage areas are combined with each other is reduced, as compared to managing workload when the storage areas are separately allocated, the writing time is prolonged since the data writing operation is performed in serial to a storage unit. Also, in such a case that a plurality of consecutive storage areas are present within the same storage unit in the first storage apparatus 7 before the save operation, these consecutive storage areas may be allocated to restore destination storage units different from each other. In this case, although there is no change in the writing time required for restoring the archive data, since a degree of parallel of input operations to the CPU 1 is increased when saving the archive data again, the input time to the CPU 1 can be shortened.

The following description will now be made of such an operation that the first storage apparatus 7 is employed. The data output buffer region 4 for each area is prepared (a step 45). The series of archive data from the second storage apparatus 8 are inputted (a step 47),

the data are stored into the buffer region 4 in correspondence to the identifiers which have been added to the data, and then data write requests are issued to the restore destination storage units (a step 49). It should be noted that when the archive data are compressed during the data saving process, there is additionally provided a process for expanding the compressed data.

Then, a judgement is made whether or not the requests are issued to write any archive data among the series of archive data read out from the second storage apparatus 8 at a time, into the corresponding storage units in the first storage apparatus 7 (a step 51). When there is still any remaining data, the process returns to the step 49 at which the predetermined process is repeated, whereas when all the requests have been issued, and the process is set to a waiting state until all responses to the write requests are returned (a step 53).

A check is made whether or not all of the responses have been returned (a step 55). If there is still any remaining response, the process returns to the step 53 at which the waiting operation is repeated. Then, all of the responses are returned, a check is made whether the whole archive data saved in the second storage apparatus 8 has been entirely restored (a step 57). If the restore operation has been accomplished, the process of the restore program 6 is ended.

It is of course that all of the archive data in each of the plural storage unit in the first storage

apparatus 7 may be used so as to be restored. In this case, the consecutive storage areas are assigned to the storage units of the first storage apparatus 7, and another name for specifying the series of archive data may be employed as a name of the file 1300 for the managing information 13. Furthermore, the sequence numbers of the areas within the first storage apparatus 7 may not be specifically set, otherwise may be set to a number indicative of a first number. Also, among the series of archive data, all archive data of plural files within any storage units in the first storage apparatus 7 may be employed so as to be restored. At this time, a plurality of file names 1300 and the area information thereof constituting a plurality of managing information may be set to a single managing information file 13, and also key information for specifying the respective managing information may be added.

As previously described, in the first embodiment, the save operation is effected from the first storage apparatus 7 to the second storage apparatus 8, and the data restore operation is performed from the second storage apparatus 8 to the first storage apparatus 7. In this case, when the access rate of the second storage apparatus 8 is extremely faster than that of the first storage apparatus 7, the series of data stored in the plurality of storage units in the first storage apparatus 7 are read out in parallel and then written into the single second storage apparatus 8 during the data save

operation. During the data restore operation, the series of data stored in the second storage apparatus 8 are read and written into the plurality of storage units in the first storage apparatus 7, so that both the data archive and restore times may be shortened.

[Second preferred embodiment]

Fig. 5 is a block diagram for showing an overall data archive restore system according to a second embodiment of the present invention.

In the first embodiment, the managing information file is required to register the managing information related to the archive data. To the contrary, in the second embodiment, the managing information is registered in the second storage apparatus 8 together with the archive data. As a consequence, since no workload is required to process the managing information related to the archive data, the operation and management for saving or restoring the archive data may be simply performed.

The second embodiment is different from the first embodiment in a data archive program 59 and a data restore program 61 which have been stored in the main storage apparatus 3 and archive data 6300 which have been written into the recording medium 63 in the second storage apparatus 8. Also, there is such a difference that starting data 6301 has been added to a front portion of the archive data 6300.

Fig. 6 illustrates a logic arrangement of the starting data in Fig. 5. As shown in Fig. 6, the logic arrangement of the starting data 6301 is data containing at least the managing information of a series of archive data. As previously stated, the managing information includes a size of each area, an identifier and a number of the storage area before a data save operation.

Fig. 7 is a flowchart for showing a process of the data archive program 59 in Fig. 5. The process of this data archive program 59 has the following differences in that steps 65 and 67 are added after the step 33 and the step 39 is substituted by steps 69 and 71, compared to that of the first embodiment.

Only these different processes will now be described and description of the same processes as those of the first embodiment is omitted. That is, a judgement is made whether or not the write operation into the second storage apparatus 8 is for the first time (a step 65). If it is the first data writing operation, the starting data is written (a step 67). If the process corresponds to the data writing operation after the first writing operation, the process advances to the step 35 at which the archive data are written into the second storage apparatus 8. It should be noted that, in this case, even when the starting data is to be written, if the managing information of the series of archive data is not clarified and thus cannot be written, only the write area or column is prepared and kept in a blank state.

Next, after the save operation of all the series of archive data has been accomplished (the step 37) and the second storage apparatus is positioned to a place where the starting data should be recorded (a step 69), the managing information such as the sizes of storage areas is written into the write column of the starting data which was blanked (a step 71). When the second storage apparatus 8 is a magnetic tape and the like, the rewind operation is needed for the positioning purpose.

Fig. 8 is a flowchart for showing a process of the data restore program 61 in Fig. 5. This data restore program 61 has a difference, as compared to that of the first embodiment, in that a step 73 is executed instead of the step 41. In the first embodiment, the managing information was read out from the managing information file 13 at the beginning of the restore process. In the process shown in Fig. 8, the managing information is read out from the second storage apparatus 8 (a step 73). Other processes are identical to those of the first embodiment.

As previously described, in the second embodiment, location information when each archive data is present before the archive data is saved from the storage apparatus 7, namely the managing information is recorded into the storage apparatus 8 together with the series of archive data. When the series of archive data is to be restored, the managing information thereof is first read out so as to perform the restore process, whereby the

workload for managing the series of archive data may be reduced.

[Third preferred embodiment]

Fig. 9 is a schematic diagram for showing an overall data archive restore system according to a third embodiment of the present invention.

In the third embodiment, there are such differences in a data archive program 75, a data restore program 77, a construction 7900 of a series of archive data written into the storage medium 79 within the second storage apparatus 8, and a control apparatus 81 of the second storage apparatus 8, as compared to those of the first embodiment. That is to say, starting data 7901 and end data 7902 have been added before and after the series of archive data 7900 stored in the storage medium 9 of the second storage apparatus 8, as compared to that of the first embodiment.

In the second embodiment, when the managing information related to the series of archive data is recorded together with the series of archive data into the second storage apparatus 8, there is data of the managing information to be determined at the last operation of the save or archive process. Therefore, after the whole series of archive data have been saved, the storage medium 8 is positioned at the starting data position and predetermined managing information is again written. To the contrary, as shown in Fig. 9, in the third embodiment,

the managing information which has been written at the end of the series of archive data is automatically reflected onto the starting data during the rewind operation by the control apparatus 81 of the second storage apparatus 8. In other words, the managing information is written into the end data 7902 positioned at the last part, the control apparatus 81 previously reads the managing information positioned at the last part while either the rewind or wind operation is carried out so as to utilize the series of archive data, and when the control apparatus 81 reaches the starting data area, it writes the managing information which has been additionally stored.

As a result, after the series of archive data of a file are saved to the second storage apparatus 8, these data may be continuously used for other purposes. Accordingly, different from in the second embodiment, for rewinding the recording medium to the starting data area, after the last archive data has been saved, a winding operation is not necessary for forwarding the recording medium to the end position of the archive data after the managing information is recorded. Then, since there is no problem that the second storage apparatus 8 cannot be used during the winding and rewinding operations, the availability of the second storage apparatus can be improved.

Fig. 10 is a logic constructive diagram of the starting data in Fig. 9 and Fig. 11 is a logic constructive diagram of the end data in Fig. 9. As shown in Fig.

10, the logic construction of the starting data 7901 is data containing at least starting information 7901a, by which the control apparatus 81 of the second storage apparatus 8 can recognize the start data, and the managing information 13 of the series of archive data. Also, as shown in Fig. 11, the logic construction of the end data 7902 is data containing at least end information 7902a, by which the control apparatus 81 can recognize the end data, and the managing information.

Fig. 12 is a flowchart for representing a process of the data archive program of Fig. 9. In the flowchart of Fig. 12, a step 83 is added instead of the step 63, in comparison with that of the second embodiment shown in Fig. 7. Also, instead of the steps 69 and 71, a step 85 is newly employed. That is to say, at the step 67 of the second embodiment, the managing information has been stored in the second storage apparatus 8 as single data similar to each archive data. To the contrary, in the third embodiment, the managing information 13 is utilized as a parameter and the writing operation of the starting data 7901 is demanded by a command to the control apparatus 81 (a step 83). In response to this command, the control apparatus 81 adds at least the starting information to the managing information 13, and then writes this managing information with the starting information into the second storage apparatus 8. It should be noted that also in this case, data with a blank kept is contained in the managing information, similar to

the second embodiment.

Also at the step 85, the managing information 13 is used as the parameter, and a request to write the end data 7902 is issued to the control apparatus 81, similar to the step 83. In response to this request, the control apparatus 81 adds at least the end information to the managing information and then writes this managing information with the end information into the second storage apparatus 8.

Since other processes are the same as those in the second embodiment, an explanation thereof is omitted.

Fig. 13 is a flowchart for a process of the data restore program in Fig. 9. In Fig. 13, only the first step of this flowchart is different from the flowchart of the second embodiment as shown in Fig. 8. That is to say, at the step 73 of the second embodiment, the managing information which has been stored as single data similar to each archive data, was inputted from the second storage apparatus 8 in response to the input request, similar to the archive data. To the contrary, at the step 87 of the third embodiment, the request to input the parameter within the starting data is issued to the control apparatus 81, whereby the managing information is inputted. The remaining processes are the same as those of the second embodiment.

Fig. 14 is a schematic block diagram of the control apparatus of the second storage apparatus in Fig. 9. The control apparatus 81 comprises a processor 89

functioning as the process apparatus therein a memory 91, at least one read unit (reading head) 97 for reading data from a storage medium 79 such as a magnetic tape or the like, at least one write unit (writing head) for writing data in the storage medium 79, a starting data sensing unit 103, and an end data sensing unit 101 for similarly sensing the end data. In the memory 91, there are provided a control program 95 which is activated by receiving a start request and end request for the data writing operation, a request for inputting parameters in the starting data, and furthermore a rewind demand which are supplied from the upper system of CPU 1 or the like, and also the archive data managing information storage region 93 within the end data for storing the managing information within the end data so as to copy (overwrite) this information when it reaches the starting position by rewinding the storage medium.

It should be noted that these requests may be issued from not only the host system but also other programs within the control apparatus 81. It should be noted that a work storage region other than the storage region 93 required for executing the control program 95 has been omitted from the drawing. Although the control program 95 may be separated into programs for every request and any one of the separated programs may be activated in accordance with the event. In this example, the request accompanies a symbol recognizable by a program for specifying the sort of the request and when the

control program 95 is activated a desirable process is executed in accordance with this symbol.

Fig. 15 is a flowchart for explaining a process of the control program in Fig. 14. Upon activation of the control program 95, a judgement is made whether or not an activating purpose corresponds the request (the step 83 of Fig. 12) for writing the starting data from the host system (a step 105). If YES, then starting information for sensing the starting data by the starting data sensing unit 103 is added at least to the managing information which has been added as the parameter of this request and then written into the storage medium 79 (a step 107), and the process of this program is accomplished. Also, if this request is not for writing the starting data, another judgement is made as to whether or not the activating purpose corresponds to a request (the step 85 to Fig. 12) for writing the end data from the host system (a step 109). If YES, then end information for sensing the end data by the end data sensing unit 101 is added at least to the managing information which has been added at the parameter for this request, and thus is written into the storage medium 79 (a step 111), so that the process of the program is ended. If this request is not for writing the end data, a check is made whether or not the activating purpose corresponds to a request (the step 87 of Fig. 13) for reading the starting data from the host system (a step 113). If YES, then based upon the information for specifying archive data, the archive data is specified to

read this starting data, the managing information is transferred to the host system (a step 115) so that the process of this program is accomplished. If this request is not for reading the starting data, a check is made whether or not the activating purpose corresponds to a request issued from the host system for rewinding the storage medium (a step 117). If YES, then the storage medium such as a magnetic tape is rewound and the process waits for a sensing report from the sensing unit 101 (a step 119). Upon receipt of the sensing report, the end data is read and the managing information contained therein is stored in the storage region 93 (a step 121). Subsequently, the process waits for a sensing report issued from the sensing unit 103 (a step 123). Upon receipt of the starting data sensing report, the starting data is read (a step 125) and a judgement is made whether or not the managing information on the starting data is coincident with the end data information (a step 127). If YES (coincident), then the process of this program is accomplished. If NO (incoincident), then the managing information contained in the starting data within the storage medium 79 is rewritten by use of the managing information contained in the end data (a step 129) and the process of this program is accomplished.

When the activating purpose is not equal to the rewind request, other requests issued from the host system will be processed. However, since this process is out of the process according to the present invention, an

explanation thereof is omitted.

A modification according to the third will now be described. At the step 105 of Fig. 15, as the method for specifying archive data in order to read the starting data, the following method is considered, wherein key data (for instance, a file name and a generation number) which has been received as a parameter of the starting data writing request from the host system when the starting data at the step 103 is written, is contained in the starting data and written into the storage medium. At the step 115, the key data is transferred to the sensing unit 103. When the sensing unit 103 senses the starting data, the above-described key data is compared with the key data contained in the starting data. If there is coincidence, it can be recognized that the key data is the corresponding archive data.

Alternatively, it may be recognized that every time the sensing report is issued from the sensing unit 103, either the starting data or the archive data is read so as to be analyzed, whereby the analyzed data corresponds to the desirable archive data. It should be understood that the request for rewinding the storage medium has been utilized as the conventional method, and is issued from the host system. In this case, there is only a rule to first read out from, the head of a series of archive data when the recorded archive data are read, and no other specific rule as to the method for issuing the rewind request at the host system and the timing of the

request issuance.

It is of course that at the step 127 shown in Fig. 15, without comparing the managing information within the end data with the managing information in the starting data, the managing information in the starting data may be substituted by the managing information within the end data without any condition.

Thus, as the method for storing the location information when archive data has been present in any storage unit, together with the archive data into the storage apparatus, when the storage medium is to be rewound in response to a request from the host system, since the managing information stored at the end portion of the series of archive data is automatically overwritten into the head portion of the series of archive data so that there is no need to rewind the storage medium only to store the archive data, data access to the second storage apparatus 8 by the subsequent job does not need be longer waited.

Also, when the written data is read to be utilized, if there is the managing information related to this data at the head portion of this read data, such information useful in processing this data is recorded on the tail portion thereof. There is a function to automatically overwrite this information on the head portion of this data during the rewind operation due to some objects, so that it is possible to provide the information useful for the host system and furthermore the

control apparatus 81 of the second storage apparatus. For instance, there exists such a method with respect to the control apparatus 81 that at the step 111, the positional information, number of data and quantity of data and the like are written into the storage medium together with end data, which may be utilized while reading the recorded data, writing another data on the recorded data, and additionally writing another data thereon.

Furthermore, in order that the data stored in the storage medium will pass through the at least one reading unit 97 prior to the writing unit 99 in the control apparatus 81 during the rewinding operation of the storage medium 79, both the end data and the starting data are sensed via the reading unit 97, a comparison is made between the end data and at least a portion of the starting data before the starting data has passed through the writing unit 99. If the comparison result is incoincident, the at least a portion of the starting data can be written, the reading unit 97 is physically separated from the writing unit 99, and the storage apparatus controls the rewind speed and also the control program is executed. As a consequence, neither the winding operation is required, nor the rewinding operation is stopped during the rewinding operation in order to process that the end data is reflected to the starting data.

Fig. 22 represents a modification of the starting data in the third embodiment. Fig. 23 is a

flowchart for showing the modification partially changed from the flowchart of Fig. 15. Fig. 24 is a flowchart for processing the modification added to the preferred embodiment of Fig. 15.

As shown in Fig. 22, an instruction parameter for suppressing a non-condition writing operation of the end data is provided for the request for writing the starting data, and also a non-condition writing suppress flag 2201a is provided in the starting data 2201a. The flag within the starting data is turned on at the step 107 of Fig. 15 and then written into the storage medium 79, and a step 2301 is newly provided between the steps 125 and 127, at which a check is made whether or not the non-condition writing suppress flag is turned on, as shown in Fig. 23. If this flag is turned on, a control is made to suppress for overwriting the end data, and updating of the managing information within the starting data may be performed by updating the starting data. At this time, as a result of judgement whether or not the rewind request is issued at the step 117 of Fig. 15. If No, then the process as represented in Fig. 24 is added to the control program 95. That is to say, as shown in Fig. 24, if there is a request for updating the starting data at a step 2401, based on the information for specifying the archive data which has been designated as the request parameter from the host system, for instance, the file name and generation number thereof, the archive data within the storage medium 79 is specified (a step 2403). Then, the

managing information 13 within the starting information is updated in accordance with the instruction given from the host system (a step 2405). If there is a non-condition write flag on request (a step 2407), the archive data within the storage medium 79 is specified (a step 2403) and this flag is turned on (a step 2409). Also, if there is a non-condition write flag off request (a step 2411), the archive data in the storage medium 79 is specified (a step 2403) and this flag is turned off (a step 2413).

Fig. 25 is a format diagram of the starting data for representing another modification of the third embodiment. Fig. 26 is a flowchart made by partially modifying a portion of the flowchart shown in Fig. 15.

When in response to the starting data writing request, the starting data is sensed, the designating parameter for reporting this fact to the request source is provided, as shown in Fig. 25, a starting data sensing report flag 2501a is employed within the starting data 2501, the flag within the starting data is turned on at the step 107 of Fig. 15, whereby this starting data is written into the storage medium 79, and further the process as defined in Fig. 26 is interposed between the steps 125 and 127. In other words, a step 2601 is employed at which a check is made whether or not the starting data sensing report flag 2501a within the starting data is turned on. If this flag is turned off, the processes defined after the step 127 are executed. To the contrary, if this flag is turned on, it is so

controlled that sensing the starting data is reported to the host system (a step 2603), and the updating operation of the managing information within the starting data may be performed as in the steps 2401, 2403 and 2405 of Fig. 24. Also, when the starting data is sensed and reported, this sensing operation may be reported together with the managing information within the end data which has been stored at the step 121 of Fig. 15.

Also, a plurality of parameters of the requests for writing the starting data by which the managing information is given within the starting data may be designated and the overwritting of the managing information in the end data can be suppressed and also the starting data sensing report can be designated by the parameters. As a result, both the method for automatically copying the end data, and the method for updating the starting data can be selectively utilized based upon intentions of users for the managing information within the starting data, so that more effective services can be provided.

[Fourth preferred embodiment]

Fig. 16 is a block diagram of an overall data archive restore system according to a fourth embodiment of the present invention.

The first, second and third embodiments related to the data save operation, and the fourth embodiment has such a feature in a method for restoring data in a case

that the archive data are read out and immediately utilized.

As shown in Fig. 16, in accordance with the fourth embodiment, basic arrangements thereof are the same as the data archive program 75, the control apparatus 81 of the second storage apparatus, and the arrangement 7900 of the archive data as described in the third embodiment. It should be noted that even when the data saving methods based on the first and second embodiments are employed, the data archive restore system according to the present invention may be realized.

In the fourth embodiment, there are newly required as new constructive elements, a data utilization program 131 to utilize data to be saved; an archive data read control program 133 for controlling read operation of the archive data; and a third storage apparatus 135 for temporarily storing the data read from the second storage apparatus. Other constructive elements are identical to those of the third embodiment.

In this embodiment, with respect to the parallel sequence of the data, data ① to ⑤ of the storage apparatus into which the head data has been stored are immediately utilized once these data are read out from the second storage apparatus 8. The data ⑥ to ⑨ which have been stored in the first storage apparatus 7 are once written into either the first storage apparatus 7, or third storage apparatus 135 directly accessible. Next, after all of the archive data have been read out from the

second storage apparatus 8, the process to read the archive data is controlled in such a manner that the data are read out from either the first storage apparatus 7, or the third storage apparatus 135. As a consequence, the storage medium within the second storage apparatus 8 is rewound at each of the first storage apparatuses 7 to which the data have been saved, and an increase in the read time required for reading the save data may be prevented.

Fig. 17 is a flowchart for explaining a process of the data utilization program in Fig. 16. As represented in Fig. 17, a content of a process for the data utilization program 131 is as follows. Upon initiation necessary data is read via an archive data read control program 133 (a step 137). A check is made whether the data is deleted (a step 139). If there is no data, then the process of this data utilization program 131 is accomplished. To the contrary, if the data still remains, after the read data has been utilized (a step 141), a judgement is made whether or not the data still needs to be inputted (a step 143). If YES, the processes as defined after the step 137 are repeatedly performed, whereas if no data input is required, then the process for the data utilization program 131 is ended.

Fig. 18 is a flowchart for representing a process of the archive data read control program in Fig. 16. Once the archive data read control program 133 is initiated, at first, desired data which has been stored in

the first storage apparatus 7 is saved into the second storage apparatus 8, so that it is confirmed that no desired data is present in the first storage apparatus 7 at this stage (a step 145). In case that the desired data is present in the first storage apparatus 7, since the data to be processed is not saved, the data is read out from the first storage apparatus 7 (a step 157) and the read data is transferred to the data requesting source (utilization program and the like) (a step 153). When no desired data is present in the first storage apparatus 7, a check is made whether or not all of the archive data have been read out from the second storage apparatus 8 (a step 147). This indicate that data to be immediately utilized are read in the buffer region 4 of the main storage apparatus 3 and data to be not immediately utilized are read from the second storage apparatus into the third storage apparatus. As a consequence, if all of the desired data have been read, another check is made whether or not all of the desired data have been further read out from the third storage apparatus 135 (a step 159). Also, in such a case where all of the desired data have not yet been read from the second storage apparatus 8, namely any desired data still remain in the second storage apparatus 8, the archive data are read out from the second storage apparatus 8 (a step 149). The read data are stored in the buffer region 4 of the main storage apparatus 3. Subsequently, a judgement is made whether or not the read data is present in the storage unit, in which

data at the head the data sequence has been stored, among the storage units of the first storage apparatus, based on the identifier of the read data (a step 151). In other words, confirmation is made whether or not the read data corresponds to the data ① to ⑤ which should be immediately utilized. If the read data is not such immediately used data, since the read data corresponds to data which is not utilized, after the read data is written into the third storage apparatus 135 (a step 155), the process returns to a step 147 so that the above-described process is repeated. It should be noted that no storage unit in the first storage apparatus to which the data is saved is employed, and alternatively the main storage apparatus 3, an expandable storage apparatus or the third storage apparatus such as other external storage apparatus may be utilized.

In case that the data ① to ⑤ has been present in the head storage unit of the first storage apparatus 7, the read data is transferred to the requesting source (a step 153) so that the process of the archive data read control program 133 is accomplished. It should be noted that when all of the archive data which have been temporarily written in the third storage apparatus 135 are read out, since all of the read data have been stored into the buffer region 4 of the main storage apparatus 3, the process of the archive data read control program 133 is ended. If a portion of the read data still remains therein, after the data is read out from the third storage

apparatus (a step 161), the read data is transferred to the data requesting source (a step 153).

It should be noted that both utilizing the archive data by way of the data utilization program 131 and restoring the archive data to the third storage apparatus 135 can be simultaneously carried out. At this time, it is of course that as to the data which have been stored at the head storage unit in the first storage apparatus 7, the process for writing the data into the third storage apparatus 135 corresponding to the step 155 is added to the step 153.

At the step 155, when the data is written into the third storage apparatus 135, the method for allocating the storage units of the first storage apparatus 7 to store this data may be based on the same number of areas and the some size as those before the save operation, a group of areas, or the smaller number of areas.

Thus, in case that the archive data are read out and immediately utilized, when the data ① to ⑤ within the head one with respect to the parallel sequence of the data, among the storage units of the first storage apparatus 7 to which the data area saved, are read out from the second storage apparatus 8, these data are immediately utilized, whereas the data ⑥ to ⑨ which have been stored in the first storage apparatus 7 are once reserved in the directly accessible third storage apparatus 135, and the reserved data are read out so as to be utilized after all of the archive data have been read

out from the second storage apparatus 8. As a result, an increase in a read time required for rewinding the storage medium within the second storage apparatus 8 for each storage unit of the first storage apparatus 7.

[Fifth preferred embodiment]

Fig. 19 is an internal constructive diagram of the control apparatus in the second storage apparatus according to a fifth embodiment of the present invention. Fig. 20 is a logic constructive arrangement of a managing information storage region in end data according to the fifth embodiment. Fig. 21 is a flowchart for showing a process of the control program in Fig. 19. Figs. 27 and 28 are logic constructive diagrams of starting data and end data in the fifth embodiment. It should be noted that since the overall constructive arrangement is arranged such that the control apparatus 163 and the arrangements of the starting data and end data in the storage medium 79 in the second storage apparatus are different from those of the third embodiment, but other constructions are the same as those of the third embodiment, a drawing thereof is omitted.

In the third embodiment, only one combination between the starting information an the end information is assumed. To the contrary, there is a different point in preparation of several sorts of combinations between the starting information and the end information. That is to say, the managing information in the end data every sort

of the end information, is stored. If the starting information is sensed, a control is so carried out that the managing information of the end information corresponding to this starting information is written into the starting data. As a result, plural sorts of data sandwiched between starting information and end information can be recorded. In other words, either the host system or the control apparatus can store more than one combination of certain data and managing information, and furthermore the managing information related to the overall combinations can be stored.

The fifth preferred embodiment will now be described in detail. As represented in Fig. 19, the control apparatus 163 of the second storage apparatus has the following different constructions, as compared to those of the third embodiment, of a managing information storage region 165 in end data and a control apparatus 163. Also, the function of the control apparatus 163 has such a different point, as compared to the function thereof according to the third embodiment, in that when request for writing starting data and a request for writing end data are issued, a parameter indicative of this sort can be designated. It should be noted that this request may be issued from the host system and/or from another program in the control apparatus 163, similar to the third embodiment.

As indicated in Fig. 20a, the logic constructive

arrangement of the managing information storage region 165 within the end data is constituted by a sort code 7902 and managing information 13. These sort code and managing information are combined to be stored, depending upon sorts of the sort codes.

Fig. 20b illustrates a storing method to store plural sorts of managing information into the second storage apparatus. With respect to the storage medium of the second storage apparatus, a combination of starting data 2701 and end data 2801 is provided for the whole of a series of archive data, and there are combinations between starting data 790a, 791a, 792a, ..., and corresponding end data 790b, 791b, 792b, ..., for every block. As this block, a unit of cylinder, track and sector may be utilized. In this case, the managing information storage region 165 in the end data is subdivided into a region for writing therein entire managing information and regions for writing therein managing information of the respective archive data 7a, 7f, 7g and 7e and so on. As previously stated, in case that the sorts of the starting data and end data are nested, the sort codes are required. After the end data is read every block data, and stored in the storage region, both the starting data and end data must be correctly written at the starting data position of the block corresponding to that when the rewind operation is performed.

As shown in Figs. 27 and 28, both starting data 2701 and end data 2801 contain sort codes indicative of

the respective sorts thereof. In other words, the starting data 2701 is constructed of starting information 7901a, a sort code 2701a, and save data managing data. Also, the end data 2801 is constructed of end information 7901b, a sort code 2701a and save data managing information 13.

As shown in Fig. 31, a process of the control program 167 has the following different points from those of the third embodiment. That is, instead of the step 107 of Fig. 15, when a demand to write the starting data is issued, the sort code 2701a instructed as a parameter of the request is added to the managing information, which are then written into the storage medium 79 (a step 169). Similarly, instead of the step 111, when a request for writing the end data is issued, a sort code 281a designated as a parameter of this request is added to the managing information 13, which are then written into the storage medium 79 (a step 171).

Also, instead of the step 121 shown in Fig. 15, the end data is read and both the sort code contained therein and the managing information are written into the managing information storage region 165 within the end data (a step 173).

To select the managing information 13 written into the starting data, the managing information within the managing information storage region 165 in the end data is obtained in which the sort code 2701a within the

starting data which has been read at a step 125 is coincident with the sort code 7902 in the managing information region 165 within the end data (a step 175).

As previously described, since plural sorts of the starting data and end data may be provided, the managing information related to the overall storage data and the managing information about the data on a portion of the storage data may be set in accordance with their purposes.

After all, the present invention owns the following features.

(a). In case that the data is saved to the same second storage apparatus which is exclusively and sequentially accessed, and the access rate of which is considerably higher than that of the first storage apparatus to which the data is saved, when the save data have been separated and stored in a plurality of first storage apparatuses, the data stored in the storage units of the first storage apparatus are parallel-read out from the respective storage units, the identifiers for specifying the data within the respective storage units are added to the read data, and the resultant data are stored in the same second storage apparatus, whereby the higher access rate of the second storage apparatus may be utilized so as to shorten the data save time.

(b). Since the location information(managing information) about the save data which has been saved in

the first storage apparatus is stored together with the save data into the second storage apparatus, and therefore the managing load of the managing information related to the save data is eliminated, both the operations and managements required for saving and restoring the data may be simplified.

(c). When as the managing information related to the save data, no decision is made that it is not the last of the save process, the managing information is written into the last of the data, the control apparatus of the second storage apparatus automatically reflects to the managing information of the data at the head position thereof during the rewind operation. As a consequence, even when the second storage apparatus is continuously used for other purposes, such an operation that after the data is written, the second storage apparatus is rewound to the head position of the data and further wound to the data end is no longer required to save the data. During this time period, since there is no case that the second storage apparatus cannot be used, the possibilities of the apparatuses may be improved.

(d). Since the control is carried out during the rewinding operation of the storage medium in such a manner that the head portion of the data is sensed before this head portion passes through the writing portion, and the managing information present at the data end is written into this head portion, the rewinding operation of the storage apparatus for this information overwrite

needs not be stopped and thus the rewinding time is not prolonged.

(e). Also, since the control is performed in such a manner that the overwrite of the managing information present at the data end on the head position without any restriction is suppressed, and when the head position of the data is sensed, this sensing fact is reported to the requesting source, both the method for automatically overwriting the managing information of the data end, and the method for updating the managing information of the head portion of the data in accordance with the intentions of the user for the managing information may be properly selected, so that the better services can be effectively provided.

As previously explained, according to the present invention, since when the data is saved from the storage unit of the first storage apparatuses to the second storage apparatus which is exclusively and sequentially accessed and has the very higher access speed or rate than that of each of the storage units, the data are parallel-inputted from the storage units thereinto, the save time can be shortened. Also, in case that the managing information of the archive data is arranged at the head position of the archive data, as the managing information is written into the last portion thereof during the data save operation, and also this managing information is automatically copied at the head portion of this data during the rewind operation, rewinding and

winding the storage medium are not repeatedly performed and the managing information on the storage data may be set at the head position of the data.

CLAIMS:

1. A storage control method by a computer including a buffer for saving a series of data into a second storage apparatus, which are separated and stored into a plurality of first storage apparatuses in such a manner that a portion of the data is stored into a certain storage apparatus of said first storage apparatuses, and a portion of data subsequent to said portion of the data is stored into other storage apparatuses of said first storage apparatuses, comprising the steps of:

(a). reading said series of data which have been stored into said plurality of first storage apparatuses, into said buffer in a parallel mode from each of said plural first storage apparatuses by a predetermined data size;

(b). adding to each of said data with a predetermined data size read into said buffer, an identifier for specifying a storage position within said plural first storage apparatuses to which said data have been stored;

(c). sequentially storing the data added with said identifier and stored in said buffer, into said second storage apparatus; and,

(d). repeating the steps defined from said step (a) to said step (c) until said series of data have been completely stored into said second storage apparatus.

2. A storage control method according to claim 1, wherein an amount of the data read into said buffer by way

of said step (a) is smaller than an amount of the data which can be stored within a predetermined time by executing said step (c) one time.

3. A storage control method according to claim 1, wherein said identifier contains information representative of a sequential relationship in said series of data.

4. A storage control method according to claim 1, further comprising the steps of, in order to restore said series of data:

(e). reading into said buffer, said data which have been stored into said second storage apparatus and have said identifier which indicates the first storage portion within said plurality of first storage apparatuses;

(f). storing into a third storage apparatus, data other than said data having said predetermined data size at the head position of said series of data which have been stored into said second storage apparatus; and,

(g). storing the data stored in said third storage apparatus into said buffer in the arranging sequence of said series of data stored in said first storage apparatuses with reference to said identifier added to each of the data having said predetermined data size.

5. A storage control method according to claim 4, wherein in said step (f), the data other than the data having said predetermined data size at the head position of said series of data stored into said second storage apparatus, is stored into said third storage apparatus in

the arranging sequence of said series of data stored in said first storage apparatuses by referring to said identifier attached to each of said data having said predetermined data size.

6. A storage control method according to claim 1, wherein information representative of each of head and last portions of said series of data is added to each of the head and last portions of said series of data stored in said second storage apparatus.

7. In a data save and restore system including a plurality of first storage apparatuses, a second storage apparatus having an access performance higher than that of said first storage apparatuses and prepared for saving data which have been separated and stored into said first storage apparatuses, a CPU for controlling said first and second storage apparatuses, and a main storage apparatus connected to said CPU, a storage control apparatus characterized in that there are provided in said main storage apparatus;

a buffer region for reading therein in a parallel mode save data from said first storage apparatus; and,

data saving means for adding an identifier for specifying a region within said first storage apparatuses into which the save data has been stored, to the save data read into said buffer region, and for writing the save data with the identifier into said second storage apparatus.

8. In a data save and restore system including a plurality of first storage apparatuses, a second storage apparatus having an access performance higher than that of said first storage apparatuses and prepared for save data which have been separated and stored into said first storage apparatuses; a CUP for controlling said first and second storage apparatuses; and a main storage apparatus connected to said CPU, a storage control apparatus characterized in that there are provided in said main storage apparatus;

a buffer region for reading therein in a parallel mode save data from said second storage apparatus;

a control module for selecting only data corresponding to an identifier for specifying a consequtive region within said first storage apparatus, into which a first arrangement of save data has been stored, among the save data read into said buffer region, for transferring said selected data to an utilization module in a data read request from the utilization module, and for storing the remaining data once into a directly accessible third storage apparatus; and,

a control module for reading the data stored in said third storage apparatus into said buffer region in an arrangement sequence of the data.

9. In a data save and restore system including a plurality of first storage apparatuses, a second storage apparatus having an access performance higher than that of said first storage apparatuses and prepared for save

data which have been separated and stored into said first storage apparatuses; and, a control apparatus for controlling said second storage apparatus, a storage control apparatus characterized in that there are provided in the control apparatus for said second storage apparatus;

a control module for recording both a starting part constructed of starting information to sense at least an immediately front part of the data in said second storage apparatus on said immediately front part, and end information to sense at least an immediately end part on said immediately end part; and,

a second module for reading the managing information within said starting part, and for sensing both the starting information and the end information during a rewind operation of said second storage apparatus so as to make the managing information within said starting part coincident with the managing information within said end part.

10. A storage control method by a computer including a buffer for saving several series of data into a second storage apparatus, which are stored into a first storage apparatus, comprising of:

(a). reading said several series of data which have been stored into said first storage apparatus, into said buffer from said first storage apparatus by a predetermined data size,

(b). adding to the head portion of said each series of data read into said buffer, starting information

which contains at least identifier for specifying said series of data from other series of data;

(c). adding to each of data read into said buffer, each identifier for specifying said series of data from other series of data and storing said data added with said information into said second storage apparatus;

(d). sequentially storing said several data added with said identifier and stored in said buffer, into said second storage apparatus;

(e). repeating the steps defined said step (a), (c) and (d) until said several series of data have been completely stored into said second storage apparatus; and,

(f). adding to the last portions of said each series of data read into said buffer, end information which contains at least identifier for specifying said series of data from other series of data and storing said data added with said information into said second storage apparatus.

11. A storage control method according to claim 10, wherein

in said step (b), adding to the head portion of said several series of data read said buffer, totally starting information which contains at least identifiers for specifying said several series of data in addition to said starting information and storing said data added with said information into said second storage apparatus, and

in said step (f), adding to the end portion of said several series of data read said buffer, totally

end information which contains at least identifiers for specifying said several series of data in addition to said starting information and storing said data added with said informations into said second storage apparatus.

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